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National Ambient Air Quality Standard for Lead

(U.S.) Environmental Protection Agency
Research Triangle Park, NC

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Under Section 109 of the Clean Air Act, the U.S. Environmental Protection Agency intends to propose a National Ambient Air Quality Standard for lead. The sources and 1975 ambient air concentrations of lead, trends in growth, and existence and potential for lead emissions control have been summarized. Emission control strategies have been developed and, under one strategy developed, the nationwide environmental impacts of establishing the standard at $1.0 \mu g/m^3$, at $1.5 \mu g/m^3$, or at $2.0 \mu g/m^3$ have been assessed. TABLES AND FIGURES.

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PB82-235573

NATIONAL AMBIENT AIR QUALITY STANDARD FOR LEAD

DRAFT

ENVIRONMENTAL IMPACT STATEMENT

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

December 1977

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NATIONAL AMBIENT AIR QUALITY STANDARD
FOR
LEAD

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OFFICE OF AIR QUALITY PLANNING AND STANDARDS
DECEMBER 1977

ABSTRACT

Under Section 109 of the Clean Air Act, the U.S. Environmental Protection Agency intends to propose a National Ambient Air Quality Standard for lead. The sources and 1975 ambient air concentrations of lead, trends in growth, and the existence and potential for lead emissions control have been summarized. Emission control strategies have been developed and, under one strategy developed, the nationwide environmental impacts of establishing the standard at 1.0 $\mu g/m^3$, at 1.5 $\mu g/m^3$, or at 2.0 $\mu g/m^3$ have been assessed.

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1.0 INTRODUCTION AND BACKGROUND

On May 7, 1974, the Administrator of EPA announced in the *Federal Register* that the Agency, although not required to do so by law, would prepare environmental impact statements on significant regulatory actions. Because the National Ambient Air Quality Standard (NAAQS) for lead, proposed under Section 109 of the Clean Air Act, meets the criteria for a significant action, the following draft impact analysis of standard implementation has been prepared.

The Draft Environmental Impact Statement (EIS), was developed before a decision was reached on the proposed standard level. Consequently, the analysis covers a range of air lead levels considered to include probable candidate standards.

Much of the input data to the EIS analysis derives from information contained in the preliminary draft of the EPA document *Control Techniques for Lead Air Emissions*. Revisions appearing in the final Control Techniques Document are not reflected in the results presented herein.

The EIS employs actual and estimated air quality data, adjusted for growth, to predict areas of the country which may exceed a particular standard level by the date for attainment. Under the assumption that emissions of lead are proportional to lead air quality, the percentage reduction in emissions necessary to attain the standard in such areas is calculated. The extent of the required rollback is heavily influenced by the large emission reductions expected with the implementation of lead phasedown regulations for gasoline and the anticipated compliance of sources with state implementation plans for control of particulate matter. As a result, two categories of stationary sources of lead emissions, primary lead and copper smelters, are identified by the EIS as requiring additional lead emission control by the attainment date of 1982. More recent analysis, however, undertaken in the preparation of the Economic Impact Assessment (EIA) and based on both revised control techniques information and better air quality modeling techniques for hypothetical plants, indicates that controls may be required for additional source categories. These include secondary lead smelters, gray iron foundries, lead-acid battery plants, and lead additive manufacturers.

BACKGROUND: EVENTS LEADING TO THE LISTING OF LEAD UNDER SECTION 108

CLEAN AIR ACT AMENDMENTS OF 1970

In 1970, Congress adopted Amendments to the Clean Air Act. The Senate Committee on Public Works, in recommending the changes to the Act, made specific reference to lead as a contaminant of broad national impact, suggesting that air quality criteria for this pollutant be issued within 13 months of enactment of the amendments.

REGULATION OF LEAD AS A FUEL ADDITIVE UNDER SECTION 211

EPA analysis of the available data on atmospheric lead singled out mobile source emissions as the largest contributor to ambient lead levels. The use of lead additives to increase the octane rating of gasoline fuels was estimated by the Agency to account for approximately 90% of the air lead observed nationwide. In early 1971, EPA determined that the most effective means of reducing atmospheric lead concentrations would be to remove or reduce the lead in gasoline and issued an Advanced Notice of Proposed Rulemaking on January 30, 1971.

Under Section 211 of the Clean Air Act, the Administrator of EPA is authorized to regulate any motor vehicle fuel additive which "causes, or contributes to, air pollution which may reasonably be anticipated to endanger the public health or welfare" or which "will impair to a significant degree the performance of any emission control device." [Section 211(C)(1)]. The January, 1971 notice outlined regulation of additive lead under both criteria; first, to gradually phase down the lead content of gasoline and, second, to establish and provide for the availability of a lead-free fuel which would not poison the catalytic convertors scheduled for installation in new model cars to reduce emissions of hydrocarbons and carbon monoxide.

In February, 1972, EPA proposed regulations requiring the availability of a grade of lead-free gasoline and a phased reduction of lead in gasoline over a four-year period (37 FR 3882). Following an extended comment period the Agency determined that the two regulations should be dealt with separately. On January 10,1973, regulations requiring the availability of lead-free fuel by July 1, 1974 were promulgated (38 FR 1255).

Re-evaluation of the health effects analysis by EPA, based on comments received, led to reproposal of the phase-down regulations on January 10, 1973 (38 FR 1258) and promulgation on December 6 of the same year (38 FR 33734). These regulations provided for a phase-down in the average lead content of gasoline to 0.5 grams per gallon over a period of four years, beginning January 1, 1975. The schedule was designed to ahcieve a 60-65 percent decrease in lead usage in gasoline. EPA determined that the phase-down schedule was reasonable with regard to protection of health and economically and technically feasible.

On December 20, 1974, the U. S. Court of Appeals for the District of Columbia Circuit set aside the phase-down regulations, following a petition by members of the additives industry. At that time, EPA suspended enforcement. On March 17, 1975, however, the Court vacated the prior judgment which served to reinstate the regulations. EPA continued to suspend enforcement until the June 14, 1976, decision by the U. S. Supreme Court upholding the regulations. A revised phase-down schedule was promulgated on September 28, 1976, which required that the pooled average of lead in gasoline be reduced to 0.5 grams/ gallon by October 1, 1979.

LITIGATION TO REQUIRE NAAQS FOR LEAD UNDER SECTION 109

During 1976, the Natural Resources Defense Council (NRDC) and others, brought suit against EPA for failing to list lead as a pollutant under Section 108 of the Clean Air Act and subsequently establish ambient air quality standards. NRDC argued that the statutory language, legislative history and purpose, and administrative interpretation of the Clean Air Act required that the EPA Administrator list pollutants under Section 108 if the pollutant is ubiquitous and "may cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare." EPA argued that the listing of pollutants under Section 108 is at the discretion of the Administrator.

The Agency had determined that the most effective means of reducing ambinet lead levels was through reduction of the lead content of gasoline. Therefore, the pollutant need not be listed even though it met the criteria of Section 108.

In NRDC et. al. vs. Train, the U. S. District Court of the Southern District of New York ruled against EPA stating:

> "There is no language anywhere in the statute which indicates that the Administrator has discretion to choose among the remedies which the Act provides. Rather, the language of Section 108 indicates that upon certain enumerated conditions, one factual and one judgmental, the Administrator "shall" list a pollutant which triggers the remedial provisions of Sections 108-110. The statute does not provide, as defendants (EPA) would have it, that the Administrator has authority to determine whether the statutory remedies which follow a Section 108 listing are appropriate for a given pollutant."

As of March 1, 1976, EPA was given thirty days to list lead under Section 108. The listing was signed on March 31, 1976, and announced in the Federal Register on April 8, 1976, pursuant to the Court's decision.

In July, 1976, EPA appealed the lower court's decision. Pending the decision of the appellate court, the one-year time-table for issuance of the air quality criteria and proposal of national ambient air quality standards for lead was stayed. On November 10, 1976, the U. S. Court of Appeals upheld the original decision. A period of nine months was allowed for the issuance of criteria and proposal of the standard. The August 10, 1977, deadline was not met due to delays in finalizing the air quality criteria document for lead which, under the Section 109, must be issued at proposal. EPA reached agreement with the litigants to reschedule the standard proposal date to December 2, 1977.

ALTERNATIVES TO THE PROPOSED ACTION

As a result of the litigation previously described, there are no regulatory alternatives to establishing the lead NAAQS. The Agency is further limited by the language of the authorizing legislation which identifies the health and welfare implications of lead air pollution described in the Criteria Document as the only basis for the NAAQS. Costs of control and availability of control technology may not be taken into account in the decision-making process.

Since the EIS was developed before a decision was reached on the proposed standard level, the analysis evaluates the impacts of three standard levels, including the proposed level for the NAAQS.

The Economic Impact Assessment is published under separate cover.

2.0 AIRBORNE LEAD IN THE ENVIRONMENT: SOURCES AND AMBIENT LEVELS

2.1 Sources of Lead in Ambient Air

Almost all airborne lead can be traced to man-made sources. That which is derived from natural origins (e.g., wind erosion of naturally lead-bearing soils or the stable end-product of radioactive radon gas releases) is believed to be negligible. Of the man-made sources, automotive emissions comprise the largest single source type (approximately 90 percent of all emissions, by weight). With regard to stationary sources, primary nonferrous smelters appear to be the most significant contributors.

2.1.1 Mobile Sources

For several decades, compounds containing lead have been added to automobile fuels to inhibit auto-ignition (engine knocking) (Lewis and Von Elbe, 1961). As automobile engine manufacturers sought to increase the compression ratio of gasoline engines (to maximize power and minimize fuel consumption), the tendency toward auto-ignition increased, requiring a higher concentration of anti-knock compounds in the fuel.

2.1.1.1 Source Types and Significance. Estimation of automotive lead emissions requires the evaluation of several factors regarding automotive vehicles and the fuels they use. These factors include (1) the distribution of the several types of vehicles--buses, trucks, cars, (2) the age distribution of automobiles, (3) the extent of which catalytic converters are in use, (4) vehicle miles traveled,

(5) fuel economy (miles per gallon), (6) gasoline sales, and (7) the lead content of gasoline.

Distribution by Type of Vehicle. The Motor Vehicle Manufacturers Association reports three broad categories of motor vehicles registered in the United States: passenger cars, buses, and trucks. In 1975, passenger cars represented 80.3 percent of all motor vehicles registered in the United States, trucks represented 19.4 percent, and buses represented only 0.4 percent. Motorcycles are not considered as a major source of mobile lead emissions because of their relatively low gasoline consumption, wide spatial distribution, and substantial off-highway use.

Most passenger cars burn gasoline and of gasoline-burning cars, a substantial proportion consume leaded gasoline. However, most gasoline-burning cars manufactured in the United States in 1975 or later years are equipped with catalytic converters, designed to reduce carbon monoxide and hydrocarbon emissions, which preclude the use of leaded gasoline. Unleaded gasoline is also required for some non-catalyst vehicles. The age distribution of the automobile population is described in more detail below.

Buses are conveniently grouped into two categories: commercial buses and school buses. In 1975, approximately 80 percent of the buses were school buses and 20 percent were commercial buses. Of the total buses, 83.2 percent, including essentially all of the school buses, consumed gasoline, while the remaining 16.8 percent consumed diesel fuel (Motor Vehicle Manufacturers Association, 1976).

In 1975, approximately 92 percent of the trucks registered in the United States used gasoline, while the remaining eight percent used diesel fuel (Motor Vehicle Manufacturers Association, 1976). This corresponds closely with the 92.2 percent of all registered trucks which were under 26,000 pounds in weight. Therefore, it is not unreasonable to assume for computational purposes that all trucks under 26,000 pounds burn gasoline while all trucks over 26,000 pounds burn diesel fuel.

Age Distribution of Automobile Population. The age distribution of passenger cars registered in the United States is presented in Table 2-1 for five model years between 1964 and 1975. The pattern of age distribution of all cars registered during any of those five model years was quite similar, with over 90 percent of the cars being between 1 and 16 years of age and with approximately ten percent being older than 10 years of age (Motor Vehicle Manufacturers Association, 1976).

The Use of Catalytic Converters and Unleaded Gasoline. Most new cars manufactured in the United States subsequent to model year 1974 utilize a catalytic converter that is intended to reduce carbon monoxide and hydrocarbon emissions. Because these converters are susceptible to lead contamination, cars so equipped must use unleaded gasoline. Using retail passenger car sales data (see Table 2-2), it is estimated that approximately 3.3 percent of the 1975 car population

TABLE 2-1

AGE DISTRIBUTION OF PASSENGER CARS IN THE UNITED STATES, 1964 THROUGH 1975

CAR AGE (YEARS)	PERCENT OF ALL CARS IN USE DURING MODEL YEAR:				
	1964	1969	1973	1974	1975
0-16+	100.0%	100.0%	100.0%	100.0%	100.0%
0-16	98.4	98.0	98.0	98.2	99.0
1-16	91.1	91.8	91.1	93.3	95.1
2-16	80.0	80.4	79.8	81.1	84.8
3-16	70.0	70.1	70.1	70.0	72.9
4-16	61.7	58.9	60.5	60.8	62.3
5-16	52.4	47.6	50.6	51.6	53.3
6-16	43.9	38.0	41.3	42.3	44.5
7-16	37.9	29.3	33.4	33.7	35.7
8-16	30.2	21.9	25.3	26.5	27.8
9-16	23.1	16.7	17.8	19.4	21.4
10-16	16.0	12.0	12.2	13.2	15.3
11-16	12.0	8.9	8.1	8.9	10.2
12-16	8.3	7.4	5.4	5.9	6.8
13-16	6.5	5.6	4.0	3.9	4.5
14-16	4.5	4.1	2.9	2.9	3.0
15-16	2.6	2.7	2.3	2.2	2.3
>16	1.6	2.0	2.0	1.8	1.0

Source: Motor Vehicle Manufacturers Association, 1976. Motor Vehicle Facts and Figures, 1976.

TABLE 2-2

RETAIL PASSENGER CAR SALES IN THE UNITED STATES, 1964 THROUGH 1975

YEAR	DOMESTIC		IMPORT		TOTAL (thousands)
	NUMBER (thousands)	PERCENT OF TOTAL	NUMBER (thousands)	PERCENT OF TOTAL	
1964	7,617	94.0	484	6.0	8,101
1965	8,763	93.9	569	6.1	9,332
1966	8,377	92.8	651	7.2	9,028
1967	7,568	90.8	769	9.2	8,337
1968	8,625	89.3	1,031	10.7	9,656
1969	8,464	88.3	1,118	11.7	9,582
1970	7,120	84.8	1,280	15.2	8,400
1971	8,681	84.7	1,568	15.3	10,250
1972	9,327	85.2	1,622	14.8	10,949
1973	9,676	84.5	1,781	15.5	11,457
1974	7,454	84.0	1,417	16.0	8,871
1975	7,053	81.6	1,590	18.4	8,643

Source: Motor Vehicle Manufacturers Association. 1976. Motor Vehicle Facts and Figures, 1976. Statistics Department, Detroit, Michigan.

were so equipped and it follows that in subsequent years an increasing proportion of the passenger car population will use unleaded gasoline.

In addition to new cars requiring unleaded fuel, there has been limited voluntary use of unleaded gasoline for pre-1975 cars. In 1974, this use amounted to slightly more than one percent of total gasoline consumption (Federal Energy Administration, 1976a).

Vehicle Miles Traveled. Total vehicle miles traveled increased from 458.2 billion in 1950 to 1,307.7 billion in 1975. Of the total vehicle miles traveled in 1975, 78.6 percent were passenger car miles, 21.0 percent were truck miles, and only 0.4 percent were bus miles (Svercl, 1977).

Fuel Economy (miles per gallon). In general, average motor fuel mileage per gallon declined during the period from 1950 to 1973, and then improved in 1974 and 1975 as shown in Table 2-3. The recent improvement is due to several factors including lower speed limits, a growing population of smaller vehicles, and engineering design emphasis on fuel economy. This improvement is expected to continue. One study has indicated that the sales weighted average fuel economy in 1977 should be 18.6 mpg for all model year cars and vary from 31.8 mpg for cars in the 2,250 pound weight class to 12.7 mpg for cars in the 5,500 pound weight class (Murrell et al., 1976).

Gasoline Sales. With the exception of 1974, annual motor fuel consumption has risen steadily since 1950 (see Figure 2-1). In

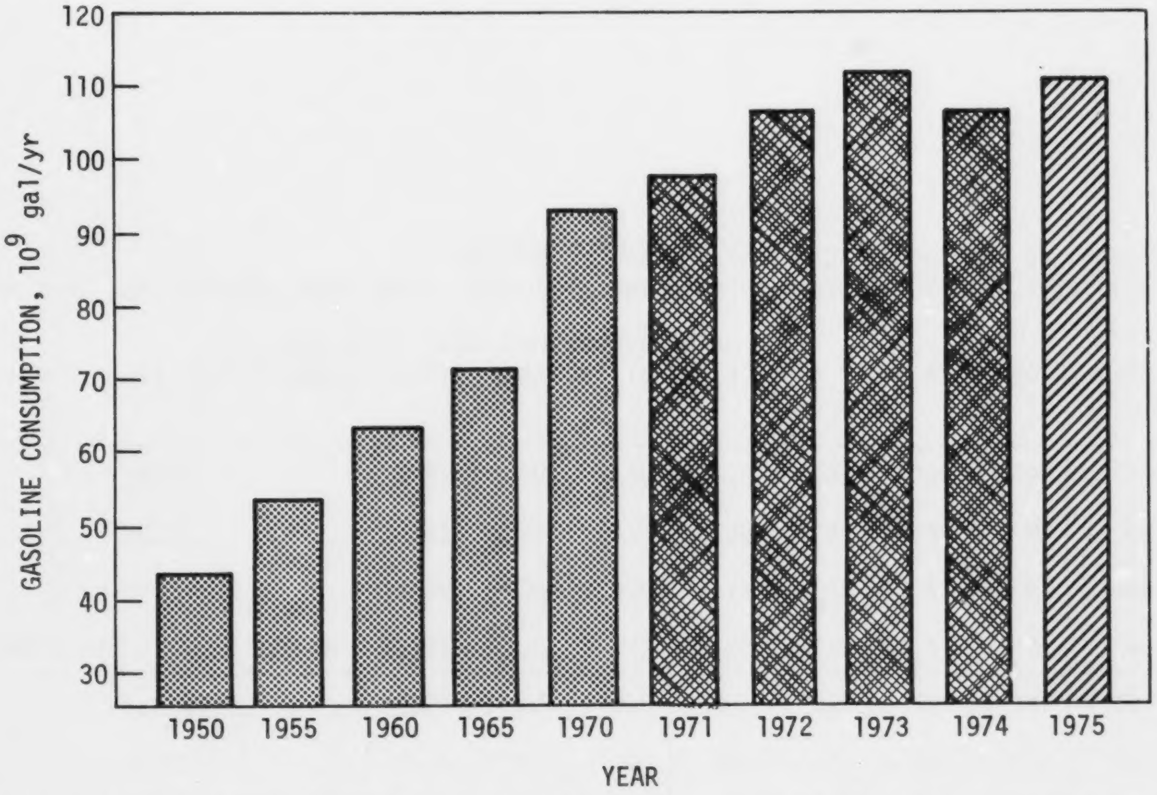
TABLE 2-3

FUEL CONSUMPTION CHARACTERISTICS BY VEHICLE, 1950 THROUGH 1975

ITEM	1950	1955	1960	1965	1970	1971	1972	1973	1974	1975
AVERAGE GALLONS PER VEHICLE	728	759	777	775	830	838	859	851	788	790
CARS	603	644	661	656	722	723	730	736	676	712
BUSES	3,752	3,021	3,040	2,844	2,491	2,382	2,165	1,991	1,920	1,937
TRUCKS	1,257	1,278	1,330	1,347	1,365	1,368	1,446	1,361	1,269	1,227
AVERAGE MILEAGE PER GALLON	12.87	12.67	12.42	12.49	12.14	12.16	12.07	11.85	12.13	12.20
CARS	14.95	14.53	1.428	14.15	13.58	13.73	13.67	13.29	13.49	13.53
BUSES	5.57	5.85	5.26	5.35	5.34	5.38	5.80	5.86	5.90	5.75
TRUCKS	8.57	8.37	7.96	8.60	8.39	8.38	8.59	8.45	8.55	8.68

Source of 1975 Data: Svercl, Paul. March 8, 1977. Highway Engineer, Federal Highway Administration. Telephone conversation.

Source of 1950 through 1974 Data: Bureau of the Census. 1976b. Statistical Abstract of the United States: 1976. U.S. Department of Commerce.



Note: Data for 1950, 1955 and 1960 include off-highway uses; data for other years are for highway uses only.

▨ Bureau of the Census. 1976b. Statistical Abstract of the United States, 1976. U.S. Department of Commerce.

▨ Motor Vehicle Manufacturers Association. 1975a. Automobile Facts and Figures, 1975. March 8, 1977.

▨ Svercl, Paul. March 8, 1977. Highway Engineer, Federal Highway Administration. Telephone Conversation.

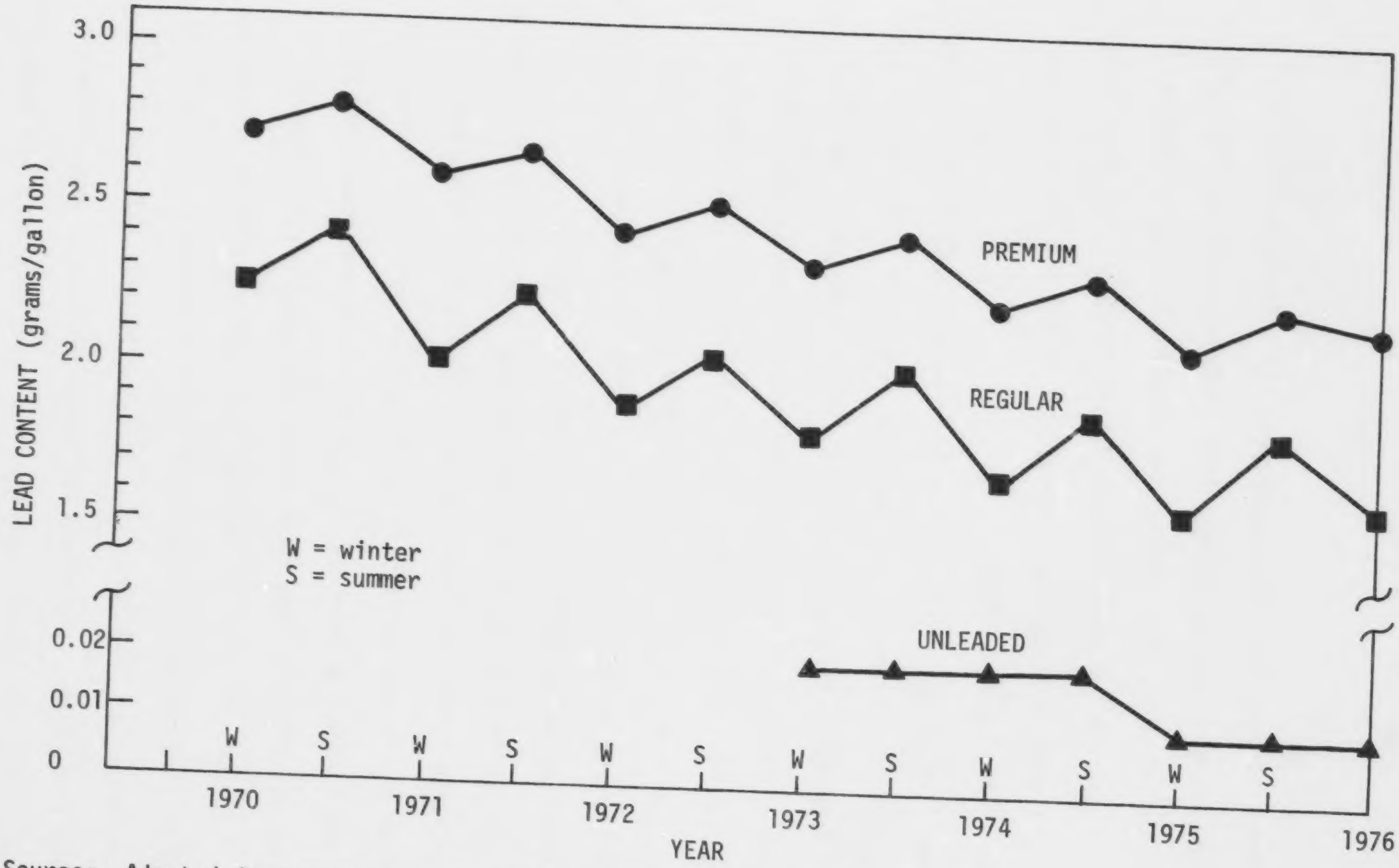
FIGURE 2-1
MOTOR FUEL CONSUMPTION IN THE UNITED STATES, 1950 THROUGH 1975

1973, total highway fuel consumption was 113 billion gallons, excluding fuel for military purposes. This included 104.5 billion gallons of gasoline of which 96.3 percent was used for highway transport while 3.7 percent was used for non-highway purposes. In 1974, there was a real drop in motor fuel consumption to 106.3 billion gallons (Bureau of the Census, 1976b).

Gasoline sales exhibit both a temporal and spatial distribution. During 1975, 57 percent of the gasoline sales took place in the six months from April through September. In the same year, the state with the highest gasoline consumption was California, where 10.22 billion gallons were consumed. California and nine other states (Texas, New York, Ohio, Illinois, Michigan, Pennsylvania, Florida, New Jersey and North Carolina) accounted for 51 percent of the total U.S. gasoline sales (National Petroleum News, 1975).

Lead Content of Gasoline. The average lead content of gasoline has declined since 1969 (see Figure 2-2). The summertime peaking trend is due to the additional tetraethyl lead (TEL) or tetramethyl lead (TML) added to increase the octane rating and compensate for the shorter distillation time required by increased product demand.

A decreasing trend in lead content combined with an increasing gasoline consumption resulted in an overall decrease of 25 percent in the amount of lead going into gasoline between 1972 and 1975. In addition to the manufacture of lower compression engines in the United States which would require less lead, many overseas outlets



Source: Adapted from various semi-annual issues of Motor Gasolines. Ella Mae Shelton. Energy Research and Development Administration, Bartlesville, Oklahoma.

FIGURE 2-2
LEAD CONTENT OF GASOLINE--NATIONAL AVERAGES, 1970 THROUGH 1976

for TEL and TML are dwindling because of low-lead legislation in foreign countries (Edwards, 1973). The average lead content of all gasoline in 1970 was 2.3 grams per gallon, compared to 1.7 grams per gallon in 1975.

With the installation of lead-sensitive catalytic converters on most new cars manufactured in the United States since 1974, the proportions of gasoline sales represented by premium and regular grades have dropped significantly, while unleaded gasoline sales have risen correspondingly (see Table 2-4).

2.1.1.2 Current and Potential Control Technology. The following general control options may be applied to reduce lead emissions from mobile sources. They are:

(a) Mechanical devices added to exhaust systems (e.g., particulate lead traps);

(b) Transportation control plans;

(c) Fuel modification; and

(d) Automobile engine modifications.

Lead Traps. The removal of lead directly from the exhaust gases can theoretically be accomplished by means of particulate traps. To be effective, such traps must be able to collect a wide range of particle sizes. In addition, exhaust back pressure must be kept to a minimum to maintain engine efficiency.

At the present time, lead traps would be considered only for the decreasing population of vehicles burning leaded gasoline.

TABLE 2-4

PERCENTAGE OF GASOLINE SALES BY GRADE, 1970 THROUGH 1976

YEAR	PREMIUM SALES ① (percent)	REGULAR SALES ② (percent)	UNLEADED SALES ③ (percent)
1970	42.6	55.8	1.6
1971	41.1	57.3	1.6
1972	38.1	60.4	1.5
1973	32.4	66.2	1.4
1974	24.5	74.3	1.2
1975	19.2	72.9	7.9 ④
1976	15.2	62.8	22.0 ④

1. Source: National Petroleum News. Mid-May 1976. Factbook Issue. National Petroleum News.

2. Calculated by difference.

3. Calculated using data in: Federal Energy Administration. November 16, 1976b. Preliminary Findings and Views Concerning the Exemption of Motor Gasoline from the Mandatory Allocation and Price Regulations. Washington, D.C.

4. Numbers directly cited from: Federal Energy Administration. November 16, 1976b. Preliminary Findings and Views Concerning the Exemption of Motor Gasoline from the Mandatory Allocation Price Regulations. Washington, D.C.

The advent of a lead-tolerant catalyst could substantially increase this population, however, and the potential need for traps.

Transportation Control Plans. A well conceived and comprehensive transportation control plan may help to reduce lead emissions, particularly in urban areas, through the application of:

(a) Controls on traffice movements and routing;

(b) Incentives for car-pools and demand-responsive transit; and

(c) Improvements in mass transit systems.

Fuel Modification. Lead emissions from mobile sources may be reduced by restricting the lead content of gasoline by replacing lead additives with non-leaded substitutes, and through the use of substitute fuels. A program of lead phase-down has been initiated by EPA with the required availability of an unleaded gasoline grade as of July 1, 1974 and a stepped phase-down of the pooled average of lead in gasoline to 0.5 g/gallon by October 1, 1979.

High effectiveness and low production costs have favored the development of lead aklyl additives over unleaded substitutes. Other compounds with antiknock characteristics include ethers, alcohols, amines, and most metal alkyls. As commercial availability has been limited by a lack of cost-effectiveness versus the lead alkyls, they have not been commercially used as antiknock additives.

Recent interest in eliminating lead additives from gasoline has spurred the development of unleaded antiknock compounds, and there are presently at least two metal-based additives which have been considered. A recently developed compound is Cerium (2,2,6,6-tetramethyl-3,5-heptanedionate)$_4$, or Ce(thd)$_4$. Preliminary tests, at a recommended concentration in gasoline of 0.5 g.Ce/gal have shown no health problems associated with its use.

Another potential substitute compound commercially available at this time is methylcyclopentadienyl manganese tricarbonyl (MMT), used in conjunction with moderately leaded gasoline to provide blending flexibility. MMT appears to be compatible with some catalysts (Bailie, 1976) but may contaminate others necessitating replacement (Consumers Union, 1977a, b). Because of the low toxicity of manganese* and the low concentrations that would be used in gasoline (Faggan et al., 1976; Ter Haar, 1975), the use of MMT is not expected to present a direct public health hazard. However, use of the additive has been associated with increased hydrocarbon emissions (Consumers Union, 1976b). As a result, the State of California has decided to ban MMT, effective September 7, 1977 (Sessa, 1977). Congress, thru the Clean Air Act has imposed a maximum concentration of MMT in gasoline of 0.0625 g/gal., effective November 30, 1977, and a total removal of MMT unless manufacturers can document that the operation of catalytic converters is not impaired.

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*Manganese has a workroom threshold limit value, TLV, of 5,000 $\mu g/m^3$ compared to 200 $\mu g/m^3$ for lead (Occupational Safety and Health Administration, 1976).

Attempts to develop new fuels have included the use of natural gas and hydrogen for more conventional vehicles and so-called fuel cells for electric vehicles. Ethanol, and possibly methanol, hold promise for near-term use in automobiles as substitute fuels. Though the combustion of pure alcohol requires major engine modifications, a blend of about 10 to 20 percent alcohol in gasoline could be utilized with only minor engine modifications and a slight mileage penalty.

2.1.1.3 Emission Trends. Legislation. There are two Federal regulations promulgated by the U.S. Environmental Protection Agency and one public law that have direct bearing on lead emissions from mobile sources. The regulations are: "EPA Regulations on Control of Air Pollutants from Motor Vehicles and New Motor Vehicle Engines" (40 CFR 85) and "EPA Regulations on Fuels and Fuel Additives" (40 CFR 80). The public law is the "Energy Policy and Conservation Act" (PL 94-163).

The first regulation (40 CFR 85) establishes hydrocarbon, carbon monoxide, and nitrogen oxide emissions standards for all new light-duty vehicles (e.g., cars, station wagons, small passenger vans). To achieve the standards with respect to hydrocarbons and carbon monoxide, United States automobile manufacturers, beginning in 1975, have installed catalytic converters on all gasoline-powered cars with engine designs which would not otherwise meet emission limits. The sensitivity of the catalysts employed requires the use of unleaded gasoline. An upward trend in the proportion of sales represented by unleaded fuel, with gradual turnover of the vehicle population, is expected to continue unless lead-tolerant catalytic converters are developed as an alternative emission control device.

The second regulation (40 CFR 80), promulgated in two parts, requires the availability of unleaded gasoline at all retail outlets, effective July 1, 1974, and provides for the phase down of the average lead content of gasoline to no more than 0.5 gram of lead per gallon by October 1, 1979.

In addition to these two Federal regulations, the "Energy Policy and Conservation Act" (PL 94-163) requires each manufacturer to obtain a progressively higher average fuel economy for all new car models to begin in 1978. The objective is to achieve an average of 18.0 mpg by 1978, 19.0 mpg by 1979, and 27.5 mpg by 1985. It should be noted that the average fuel economy of all 1977 model years cars is estimated to be 18.6 mpg (Murrell et al., 1976), placing the fuel economy performance at least one year ahead of the required schedule.

Average Emission Rate. One study of mixed urban and suburban driving has shown that 75 percent of the lead in gasoline is exhausted to the atmosphere. The remaining 25 percent is retained in either the crankcase oil or the engine and exhaust system, in approximately equal amounts (Hurn, 1968). In addition to the lead emitted from combustion, a small amount is lost through evaporative emissions from the fuel tank and carburetor.

During 1975, the average motor vehicle consumed 790 gallons of gasoline with an average lead content of 1.69 grams per gallon, emitting to the air approximately 1.0 kilogram (2.2 pounds) of lead. Estimated on-highway mobile source emission of lead from the combustion of gasoline can be calculated in three ways based on:

(a) Gasoline sales;

(b) Vehicles miles traveled; and

(c) Lead consumption at TEL plants.

Based on gasoline sales, the on-highway mobile source emissions for 1975 amounted to 140,200 tons. Using data on vehicles miles traveled, 136,200 tons of lead were emitted, while lead emissions based upon lead consumption at TEL plants amounted to 141,300 tons.

Projected Lead Emissions. The legislation cited in the previous section will serve to reduce mobile source lead emissions. Estimates of the resulting decrease of emissions have been calculated using the following assumptions:

(a) 75 percent of the lead in gasoline is emitted from the tailpipe over the lifetime of the vehicle (Hurn, 1968);

(b) Medium-duty trucks consume three percent of the total gasoline and they average ten miles/gallon (Motor Vehicle Manufacturers Association, 1977a; Commercial Car Journal, 1974);

(c) Leaded gasoline contains 2.0 g Pb/gallon and unleaded contains 0.05 g Pb/gallon (actual value for unleaded gasoline presently lower than this); the pooled average for future years is shown in Table 2-5;

(d) The percentage of pre-1975 automobiles will vary in future years as shown in Table 2-5;

TABLE 2-5

SUMMARY OF AUTOMOTIVE FACTORS

YEAR	PERCENTAGE OF PRE-1975 CARS	AVERAGE FUEL ECONOMY (mi/gal)	POOLED AVERAGE, LEAD IN GASOLINE (g Pb/gal)
1974	100.0	12.4	2.0
1975	88.8	12.5	1.9
1976	74.5	--	1.6
1977	61.5	13.3	1.2
1978	49.4	14.0	1.0
1979	39.6	14.8	0.5 ①
1980	29.2	15.7	0.5
1981	21.3	16.8	0.47
1982	15.0	17.9	0.34
1983	10.3	19.1	0.25
1984	7.1	20.4	0.19
1985	5.2	21.7	0.15
1986	3.9	--	0.13
1987	2.8	--	0.11
1988	2.1	--	0.09
1989	1.7	--	0.08
1990	0.0	26.2	0.05
1995	0.0	27.4	0.05

1. Based on the gasoline additive phasedown regulation.

Source: Wilson, James. July 14, 1976a. U.S. Environmental Protection Agency. Personal correspondence.

(e) The average fuel economy for vehicles weighing less than 10,000 pounds will vary in future years as shown in Table 2-5;

(f) The total number of vehicles miles traveled annually is assumed to follow recent trends and increase each year by 31 billion miles (Motor Vehicle Manufacturers Association, 1975a); and

(g) Small refiners (<30,000 barrels per day) with a possible exemption from the 0.5 g Pb/gallon phasedown limitations are assumed to constitute a negligible portion of the market.

Based on the automobile replacement rate reported by the Motor Vehicle Manufacturers Association, essentially all automobiles using leaded gasoline would be retired by 1990. Medium-duty trucks (greater than 10,000 pounds gross vehicle weight and less than 26,000 pounds*) and off-highway users may still require leaded fuel. These trucks consume three percent of total gasoline, while off-highway uses (gasoline powered tools, agricultural equipment, and snowmobiles) account for approximately four percent of the gasoline consumed. The off-highway sources have different emission characteristics than mobile sources, generally are not affected by mobile source control strategies, and are widely dispersed; therefore, they are not included in this discussion.

Based on the factors enumerated above, and the expected increase in fuel economy as specified in PL 94-163 (Energy Policy and Conservation Act), lead emissions from mobile sources in 1985 would be approximately 11 percent of the 1975 estimated mobile lead emissions (or an 89 percent reduction) and in 1995 would be about 8 percent of the 1975 values (or a 92 percent reduction). Most of the emission reduction would occur in the ten years between 1975 and 1985 because during those years the majority of the cars using leaded gasoline would be replaced by models requiring unleaded fuel. Thereafter, the annual reduction would be smaller as the percentage of pre-1975 models shrink to five percent or less of the total vehicle population.

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*Nearly all trucks with gross vehicle weights greater than 26,000 pounds use diesel fuel (which does not contain lead) and, therefore, would not affect the analysis and have been disregarded in this study.

After 1990 (when essentially all replacement of pre-1975 cars is expected to be accomplished) no additional reduction of lead emissions by retirement of vehicles using leaded gasoline is anticipated. Moreover, the improvement in average fuel economy resulting from the Energy Policy and Conservation Act will taper off after 1985, reaching a plateau by 1997. At the same time, however, the number of vehicle miles traveled should increase each year. The net effect of these conditions would be an incremental reduction in lead emissions between 1985 and 1995 of only three percent. Under the present regulation, no reduction in emissions from medium-duty trucks occurs and small quantities of lead are still expected to be emitted from vehicles using unleaded gasoline assumed to contain 0.05 g Pb/gallon. Thus, the reduction relative to 1975 lead mobile emissions can never reach 100 percent. The lead emissions for 1979, 1980, and 1981 would be fairly constant because the pooled averages for these years do not vary appreciably (as shown in Table 2-1).

2.1.2 Stationary Sources.

The annual supply of lead to U.S. industry is furnished by primary smelters, secondary smelters, ore and metal imports, industry, stocks; and government stockpile releases. In addition to these sources, lead is emitted to the air from a variety of industrial applications and uses.

Stationary source emissions of lead are classified as stack emissions and fugitive emissions. The former are released from on-site stacks ranging from tens to hundreds of feet in height and the subsequent behavior of the emitted material has been reasonably well studied and documented. Fugitive emissions, as the name implies, may occur throughout the facility and are more difficult to define, measure and control. Sources of fugitive emissions include leakages from process buildings, wind erosion of slag piles, and dust stirred up by automotive traffic, particularly on unsurfaced roads near major point sources.

2.1.2.1 Source Types and Significance. Twenty-three industries have been identified as being important emitters of airborne lead (U.S. Environmental Protection Agency, 1977a). Table 2-6 lists these industries along with their uncontrolled emission factors and 1975 emissions (after control). The industries listed contributed almost 90 percent of the 1975 nationwide stationary source lead emissions. For the purpose of analysis, 1975 has been adopted as the baseline

TABLE 2-6

LEAD EMISSIONS INVENTORY, 1975 NATIONWIDE VALUES

INDUSTRY	1975 PRODUCTION	EMISSION FACTOR		COMPLIANCE CONTROL FACTOR (percent)	CONTROLLED ③
		STACK	FUGITIVE		
FERROALLOY	2,215 x 10^6 tons	①	--	89	84
BATTERY	48.3 x 10^6 batteries	27.69 lbs per 1,000 batteries	--	85	100
PRIMARY LEAD	642,000 tons	68.5 lbs/ton	7.3 lbs/ton	98.2 ④	2,734
SECONDARY LEAD	604,600 tons	56 lbs/ton	0.4 lb/ton	95 ④	954
PRIMARY COPPER	1.38 x 10^6 tons	20.9 lbs/ton	3.6 lbs/ton	92.6 ④	3,461
GASOLINE ADDITIVES	326,000 tons	5.2 lbs/ton (sludge pit, process vents); 41.3 lbs/ton (lead recovery)	--	92	1,333
CAST IRON FOUNDRIES	27.8 x 10^6 tons of lead processed	0.44 lb/ton	--	70	1,841
COAL-FIRED UTILITIES	182,200 MWe	55.3 lbs/MWe	--	92	403 ②
OIL-FIRED UTILITIES	78,420 MWe	56.1 lbs/MWe	--	0	2,200 ②
MUNICIPAL INCINERATORS	11.67 x 10^6 tons	0.6 lb/ton	--	64	1,254 ②
IRON AND STEEL	①	①	--	①	1,227
ORE CRUSHING AND GRINDING	352 x 10^6 tons	0.012-0.3 lb/ton	--	25 to 27	544
PRIMARY ZINC	415,000 tons	20.85 lbs/ton	--	97.3	124
BRASS AND BRONZE	232,000 tons	22.75 lbs/ton	--	98	52

TABLE 2-6 (concluded)

LEAD EMISSIONS INVENTORY, 1975 NATIONWIDE VALUES

INDUSTRY	1975 PRODUCTION	EMISSION FACTOR		COMPLIANCE CONTROL FACTOR (percent)	CONTROLLED ③
		STACK	FUGITIVE		
LEAD OXIDE PRODUCTION	500,000 tons	0.44 lb/ton	--	0	110
PIGMENT PRODUCTION	73,000 tons	--	--	--	13
CABLE COVERING	500,000 tons of lead processed	0.5 lb/ton	--	0	125
CAN SOLDERING	134×10^6 base boxes	0.5 ton/10^6 base boxes	--	0	67
TYPE METAL CASTING	6.3×10^6 tons	0.25 lb/ton	--	50% of industry at 80%; 50% at 0%	480
METALLIC LEAD PRODUCTION	113,503 tons	1.5 lbs/ton	--	0	85
CEMENT PRODUCTION					
Wet	32.5×10^6 tons	0.10 lb/ton	--	93	137
Dry	39.5×10^6 tons	0.11 lb/ton	--		207
LEADED GLASS	492,000 tons	5 lbs/ton	--	95	62
AUTOMOBILE EMISSIONS	--	--	--	--	140,200

1. See Appendix V for discussion of 1975 emission calculation.
2. Includes crankcase oil combustion.
3. To the extent that the industry was controlled.
4. For stack emissions only, zero percent for fugitive emissions.

year as more recent information is not available on a consistent basis for all the industries listed.

Ferroalloy Producers. There are 48 ferroalloy plants in the United States which produced a total of 2.22 x 10^6 tons (2.01 x 10^6 metric tons) of ferroalloys in 1975. The majority of the plants are concentrated in Alabama, Pennsylvania, and Ohio with the remainder scattered in 13 other states. Most ferroalloy plants have capacities below 25,000 kilowatts electric (kWe) while ten plants have a capacity in the 25,000 to 75,000 kWe range, and ten have capacities over 75,000 kWe. Lead emissions in 1975 from this industry were 84.3 TPY, assuming a compliance control factor* of 89 percent.

Lead-Acid Battery Plants. There are 280 battery plants** in the United States, producing approximately 48,325,000 batteries in 1975. The plants are scattered fairly uniformly throughout the country, with some concentration occurring in New York, New Jersey, Pennsylvania, and California. Plant sizes range widely. Plants with a lead oxide (PbO) mill have a slightly larger emission factor than those without mills. Total 1975 lead emissions are estimated to be 100.4 tons based on a compliance control factor of 85 percent.

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*The degree of compliance for a given industry, expressed as a percentage, is a measure of the number of plants operating with the required SIP control devices. Numerically, this compliance factor is the ratio of the tons of airborne particulate matter controlled by the industry relative to the tons which would be emitted by the industry. Consider, for example, an industry where 80 percent of the plants have SIP control devices collecting 90 percent of the airborne particulate matter. The degree of compliance would theoretically be 72 percent. In actuality, the reported compliance factors, based on emissions, may be slightly different since not all plants may have achieved the identical level of control.

**With more than ten employees; producing lead-acid storage batteries.

Primary Lead Smelter. There are six primary lead smelters in the United States, that is, smelters which use lead ore as the primary feedstock. These smelters accounted for the production of 642,000 tons (582,000 metric tons) of lead in 1975. The six smelters may be classified as relatively high emitters of lead (the older smelters in the western part of the United States) and relatively low emitters (the newer smelters located in Missouri). Emissions from each of these facilities were obtained from emission factors, plant production statistics and compliance control factors of 98.2 percent for stack emissions and zero percent for fugitive emissions. Total 1975 lead emissions from this industry are estimated to have been 2,374 tons (16 percent of the total emissions from stationary sources).

Secondary Lead Smelters. There are 93 secondary lead smelters in the United States, that is, smelters for which the feedstock is generally used lead products, primarily battery scrap and lead residues. These smelters produced 604,000 tons (548,000 metric tons) of lead in 1975. Plants are distributed more or less uniformly throughout the country. Total emissions of lead for this industry in 1975, including fugitive emissions, are estimated to be 973 tons based on a compliance factor of 95 percent for stack emissions and zero percent for fugitive emissions.

Primary Copper Smelters. There are 15 primary copper smelters in operation in the United States. They produced approximately 1.38 million tons (1.25 million metric tons) of copper in 1975. Individual plant capacities range from 15,000 to 300,000 tons per year (TPY). All plants are located in the western region of the United States near the ore deposits. Lead is contained in the input material to both the roasting and smelting processes and is emitted as part of the flue dust produced. Lead emissions from the copper smelting industry, including fugitive emissions, are estimated to be 3,460 TPY, based on a compliance control factor of 92.6 percent for stack emissions and zero percent for fugitive emissions.

Gasoline Additive Manufacturing (Lead Alkyl Production). There are six gasoline additive manufacturing plants in the United States, producing a total of 326,000 tons (296,000 metric tons) of lead additive in 1975. These plants are located in California, New Jersey, Louisiana and Texas. Based on emissions factors for the various industrial processes employed, production data and estimated compliance factors, lead emissions from this industry were estimated to be 1,330 tons (1,210 metric tons) in 1975. Particulate emissions originate only from the lead smelting furnace, alloy reactor and the lead recovery furnace. All other emission points exhaust lead in alkyl vapor form.

Gray Iron Foundries (Cast Iron). In 1975 there were 1,519 gray iron foundries in the United States, and together they produced 16.7

million tons (15.1 million metric tons) of castings. The presence of lead in the raw ores resulted in estimated emissions of 1,841 tons based on a compliance control factor of 70 percent and internal recycling due to a 40 percent rate of bad castings.

Combustion of Crankcase Oil. The quantity of waste automotive lubricating oil that is generated annually has been estimated to be between 400 and 730 million gallons (U.S. Environmental Protection Agency, 1974b; American Petroleum Institute, 1974; Weinstein, 1974a), and the total amount of waste crankcase oil burned as fuel in 1975 was 274 million gallons. Values for the lead content of waste crankcase oil range from 800 ppm to 11,200 ppm (Chansky et al., 1973); but a composite waste crankcase oil representing a nationwide, all-season sample had a lead content of 8,400 ppm (American Petroleum Institute, 1975).

While there are studies to indicate which type of facilities can burn waste crankcase oil (e.g., Chansky et al., 1974), there are no data indicating the amounts used by different facilities. It was assumed in this report that one-half of the oil would be used in oil-fired power plants, one-third in coal-fired utilities, and one-sixth in municipal incinerators. Although this breakdown is somewhat arbitrary, it does allow for a reasonable geographical distribution of lead emissions from crankcase oil combustion. Depending on the types of facilities assumed to burn waste crankcase oil, different emissions may differ since 50 percent and 80 percent are used as emission factors when the crankcase oil is blended with utility oil and solid fuels (coal and trash) respectively. Assuming that crankcase oil is exclusively blended with utility oil, 4,300 tons of lead emissions would be expected from this industry in 1975. Using the mix of facilities described above--oil-fired and coal-fired power plants as well as municipal incinerators--would increase this figure to 5,600 tons.

Coal-Fired Power Plants. In 1975, there were 380 coal-fired power plants (above 25 megawatts electric equivalent) in the United States, consuming approximately 412 million tons (374 million metric tons) of coal as either a primary or auxiliary fuel. Based on an average lead content of coal of 8.3 ppm and assuming for the purpose of analysis that about 91.3 million gallons of waste crankcase oil were burnt at these power plants, emissions of lead from this industry were estimated to be 403 tons. This includes amounts contributed by waste crankcase oil usage based on a compliance control factor of 92 percent.

Oil-Fired Power Plants. In 1975, there were 260 oil-fired power plants (above 25 MWe equivalent) in the United States consuming 81.8 million bbl (13 x 10^6 m^3) of distillate and 554 million bbl (881. x 10^6 m^3) of residual oil as either a primary or auxiliary fuel.

Since the lead emission factor for oil combustion is dependent on the lead content in the oil and as an individual plant breakout by type of oil used was not available, a weighted average of 0.9 ppm of lead in oil was used. Assuming that 50 percent of the lead in oil is emitted (U.S. Environmental Protection Agency, 1977a) and that approximately 137 million gallons of waste crankcase oil were burnt in these power plants, lead emissions in 1975 were estimated to be 2,200 tons, mostly due to crankcase oil usage.

Municipal Incinerators. In 1975, 143 municipal incinerators in the United States burned 11,669,000 tons of refuse and are assumed to have used approximately 45.7 million gallons of waste crankcase oil as fuel. The vast majority of the installations are in the northeastern section of the country. Based on an emissions factor of 0.4 pound of lead per ton of refuse, the above assumed quantity of waste crankcase oil burnt and a compliance factor of 64 percent, nationwide lead emissions in 1975 from municipal incinerators were estimated to be 1,254 tons.

Iron and Steel Plants. There are six processes at iron and steel plants which are potential lead emitters due to the presence of lead as a trace metal in iron ore. These processes include sintering, coking, blast furnaces, basic oxygen furnaces, open hearth furnaces, and electric arc furnaces. In 1975, there were 160 iron and steel plants throughout the United States, and the nationwide emissions of lead from these plants were estimated to be 1,227 tons.

Ore Crushing and Grinding. Lead, zinc, and copper ore mining, crushing, and grinding operations, which are confined mostly to the western states, together contributed about 544 tons (493 metric tons) of lead to the nationwide total of lead emissions in 1975. The lead-containing ore mining operations are located almost exclusively in Missouri, Colorado and Idaho. Emissions are basically fugitive in nature, and because of the large particle sizes and high specific gravities of the dust, fallout occurs within a short distance from the source.

Primary Zinc Smelting. Estimated zinc production in 1975 was 445,000 tons (404 thousand metric tons). The zinc ore concentrates contain lead, varying from less than 1 percent up to 5 percent. The amount of lead released to the atmosphere is dependent on initial ore concentration. Lead emissions in 1975 were estimated to be 124 tons (112 metric tons) resulting from sintering and retorting operations.

Brass and Bronze Production. Production of brass and bronze alloys was estimated to be 232,000 tons (210 x 10^3 metric tons) in 1975, produced in reverberatory, rotary, crucible, or electric induction furnaces. Some of the alloys produced--leaded red brass, semi-red brass, high-leaded tin bronze, aluminum bronze, and leaded nickel bronze contain significant amounts of lead. The particulate emission factor is approximately 70 pounds/ton of charge with lead contents ranging from 7 to 58 percent. Estimated lead emissions from this source were at 52 tons (47 metric tons in 1975).

Lead Oxide Production. Approximately 500,000 tons (454,000 metric tons) of litharge (lead oxide) and black oxide were produced in the United States in 1975. Based on an average lead emission rate of 0.44 pounds/ton of product, national lead emissions from this industry were estimated to be 110 tons (100 metric tons) in 1975.

Pigment Production. Lead pigment production for 1975 was estimated to be 73,000 tons (66.1 x 10^3 metric tons), the majority of which was red lead and lead chromate. Lead emissions in 1975 after control were estimated to be 13 tons (11.8 metric tons).

Cable Covering Manufacturing. Consumption of lead by cable covering facilities was 50,000 tons (45,500 metric tons) in 1975. Based on a throughput to consumption ratio of ten to one, this implies that about 500,000 tons of lead were processed through internal recycling. Using an emission factor of 0.5 pound of lead/ton of lead processed, 1975 lead emissions were estimated to be 125 tons (113 metric tons).

Can Soldering. It has been estimated that metal can production in 1975 included 134 million base-boxes* of soldered steel cans. Lead emissions in 1975 from the soldering operation are estimated to be 67 tons (60 metric tons), based on an emission factor of 0.5 ton of lead per million boxes.

Type Metal Casting. Taking into account the metal ore cycle-to-replacement factor, it is estimated that of the 6.3 million tons of lead recycled approximately 16,200 tons (14,740 metric tons) of lead were consumed by type metal casting operations. Based on a lead emission factor of 0.25 pound/ton recycled and a compliance of 40 percent, lead emissions in 1975 were estimated to be 480 tons (436 metric tons).

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* A base box is equivalent to 20.23 m^2 (218 ft^2) of surface area.

Metallic Lead Production. Approximately 200,000 tons (180 x 10^3 metric tons) of lead were consumed in the manufacture of ammunition, bearing metals, weights and ballasts, and other products in 1975. Lead emissions from the 87,000 tons of lead processed for ammunition and bearing metal are negligible and the lead emissions from other processes are estimated to be 85 tons (77 metric tons) in 1975.

Cement Production. About 72 million tons (65 x 10^6 metric tons) of cement were produced in 1975 by two methods described as dry and wet process. Production of cement by the dry process was estimated to be 39.5 million tons (35.8 million metric tons). Wet process production in 1975 was estimated to be 32.5 million tons (29.5 million metric tons). Lead is an incidental trace element in the raw materials of both processes. Emission factors for these processes are estimated to be 0.11 pound/ton and 0.10 pound/ton, respectively. Assuming an overall compliance factor of 93 percent, lead emissions in 1975 were estimated to be 207 tons (188 metric tons) from the dry process and 137 tons (124 metric tons) from the wet process.

Leaded Glass Production. Leaded glass production was estimated to be 492,000 tons (446 x 10^3 metric tons) in 1975 and lead emissions were estimated to be 62 tons (50 metric tons) using an emission factor of 5.0 pounds/ton of glass and a compliance control factor of 95 percent.

2.1.2.2 Current Control Technology for Stationary Source Emissions. Except for some gaseous emissions from the lead alkyl industry (i.e., gasoline additive manufacturing), lead is usually emitted in the form of particulates from industrial sources. Consequently, control devices for lead are usually the same as those used for total particulates, namely, baghouses or fabric filters (FF), wet scrubbers or collectors (WC), and electrostatic precipitators (ESP).

The collection efficiency of these three types of control devices drops with decreasing particle size, while it is evident that smaller diameter particulates have higher concentrations of lead (Natusch et al., 1974; Greensburg, 1976). Collection efficiency usually drops for particles around 1 micron in diameter, and been some "high efficiency" control devices (99.5 percent control) are only 90 percent effective at removing these small particles. On the other hand, many of the major lead sources emit fumes rather than particulates, and any effect due to surface area differential would be small. Additionally, the widespread use of baghouses, which are not as sensitive to differences in particle sizes as the other control devices, serves to reduce any control efficiency differences.

Fabric Filtration. Fabric filters, usually in the shape of a bag, are used to trap particulates through the mechanics of inertial impaction, diffusion, and direct interception. Collection efficiencies for well-designed baghouses exceed 99 percent, especially when a cake builds up on the filter and sieving becomes an important factor in collection. The efficiency of fabric filters is, however, more sensitive to flow fluctuations and temperature than scrubbers or ESP's.

Electrostatic Preciptators. Electrostatic precipitation depends upon the collection of previously charged particles from an oppositely-charged collection plate. ESP's are usually not sensitive to flow fluctuations and they are capable of treating very large gas volumes at various gas temperatures.

Wet Scrubbers. Venturi scrubbers, which are the most common type of scrubbers used by those lead-emitting industries which use scrubbers only, have small space requirements and can accommodate flow variations. Water usage, water cleaning, and sludge generation are inherent limitations to the use of scrubbers, but when there are relatively low flow rates (<100,000 acfm) and high particulate concentrations, the venturi scrubber is often specified.

2.1.2.3 Emission Trends. In order to develop emission trends for stationary sources, it is necessary to establish a baseline (in this case, for 1975) inventory. The tons of emissions are calculated by multiplying together three factors--(1) an emission factor, usually expressed as pound of lead emitted per ton of production and as taken from Control Techniques for Lead Air Emissions (U.S. Environmental Protection Agency, 1977a), (2) the production rate in tons per year, and (3) a compliance control factor. This last factor is used to account for the amount of control for total particulates (and, hence, lead particulates) achieved by each industry by 1975 in response to State Implementation Plans for control of total suspended particulate matter (TSP). The degree of compliance, based on work performed for the Divison of Stationary Source Enforcement (Massoglia, 1976a), is a measure of the number of plants which had installed the necessary SIP controls by 1975. The compliance control factor, presented in Table 2-6 is a combination of the degree of compliance (i.e., number of plants) and the SIP control factor, and indicates the percentage of tons of lead controlled in 1975 for an industry. The 1975 lead emissions inventory can then be determined either as a nationwide summation across individual industries or as a summation of different industries within individual Air Quality Control Regions (AQCR's).

For the 11 major stationary source categories, emissions inventories for subsequent years--1982, 1985, and 1995--can be extrapolated from the 1975 inventory using industrial growth rates, present industrial capacity factors, and the applicable emissions control factors. The growth rate is the percentage of annual production by which an industry would be expected to grow for each subsequent year. The capacity factor represents the 1975 production as a percentage of the total-industry capacity. These two factors are used to determine the year of full capacity, i.e., when the growth rate indicates that present unused existing capacity would be filled. These factors are presented in Table 2-7.

It is necessary to predict the year in which full capacity will be achieved to assign the proper control factors to increased production related to industrial growth. For purposes of future lead emissions inventory development, it has been assumed that existing unused capacity would be utilized before any new production facilities are built. Thus, increased production until the estimated year of full capacity would be controlled according to factors associated with the State Implementation Plans (SIP) for total-particulate ambient air concentration standards, while production thereafter would be controlled to the extent provided by the New Source Performance Standards (NSPS) for particulate emissions at specific types of new facilities.

SIP Control. On November 25, 1971, EPA established national primary and secondary ambient air quality standards for particulate matter (40 CFR 50.6-50.7). The Clean air Act (Section 110) requires that each state develop "a plan which provides for implementation, maintenance and enforcement of such primary standards in each air quality control region (or portion thereof) within such State." The resulting SIP's required the control of particulates from a number of stationary sources, many of which have lead as constituent of the total particulate emission. SIP control factors were computed based on the average control efficiencies required by the states in

TABLE 2-7

FACTORS FOR PROJECTING FUTURE LEAD EMISSIONS

INDUSTRY	GROWTH RATE	1975 CAPACITY FACTOR	ESTIMATED YEAR OF FULL CAPACITY	SIP CONTROL FACTOR	NSPS CONTROL FACTOR
FERROALLOY	2	90	1981	99.5	99.5
STORAGE BATTERY	5	76	1981	85	85
PRIMARY LEAD SMELTER	1.5	83	1988	98.9	99.7
SECONDARY LEAD SMELTER	3.2	68	1988	97.5	99.3
PRIMARY COPPER SMELTER	3	73	1986	96.2	96.2
GAS ADDITIVE	-16	--	--	--	--
CAST IRON	2	93	1979	88.9	88.9
MUNICIPAL INCINERATOR	0	--	--	--	--
COAL-FIRED UTILITIES	5	100	1975	98	98.7
OIL-FIRED UTILITIES	2.5	100	1975	0	0
IRON AND STEEL	2.5	76.2	1987	--	--
Sintering	--	--	--	99.4	99.4
Coking	--	--	--	72.3	72.3
Blast Furnace	--	--	--	99.6	99.6
Open Hearth	--	--	--	90.2	90.2
Basic Oxygen Furnace	--	--	--	99.7	99.7
Electric Furnace	--	--	--	84.3	98.1

their SIP's and Appendix B of the Requirement for Preparation, Adoption, and Submittal of Implementation Plans (40 CFR 52). From Table 2-3 it can be seen that SIP control factors are generally $\geq$ 80 percent and often $\geq$ 90 percent.

In 1975 most of the major stationary lead emitters were in a fairly high degree of compliance (in terms of numbers of plants) as inferred by comparing the compliance control factors in Table 2-2 with the SIP control factors in Table 2-3 and by recalling that the compliance control factor is the product of the degree of compliance and the value of SIP control. Emission control techniques for total particulate (e.g., baghouse, scrubbers, and electrostatic precipitators) are the same as for control of lead emissions, and therefore the NAAQS for particulate matter has already and will continue to result in some control of lead. It is assumed that by 1982 all of the industries requiring SIP control would have a 100 percent degree of compliance and the compliance control factors would be identical to the SIP control factors. The improvement in compliance, then, would account for significant reductions in stack emissions in 1982 relative to 1975.

NSPS Control. Section 111 of the Clean Air Act provides the authority for the EPA Administrator to propose and promulgate regulations for a category of new stationary sources which "causes or contributes significantly to air pollution which may reasonably be anticipated to endanger public health or welfare." The first standards of performance for new stationary sources (New Source Performance Standars, or NSPS) were promulgated in December 1971. By January 13, 1977, particulate standards had been promulgated for 13 source categories and had been proposed for two additional source categories.

No standards of performance have been promulgated or proposed specifically to regulate lead emissions. However, promulgation of additional new source performance standards is being considered, including promulgation of a lead regulation for process equipment operated at lead-acid storage battery plants. The scheduled date for proposing such a regulation is December 1977.

For 1982 and 1985, the effect of the NSPS control factor, with regard to lead emissions, is very small due to the fact that, in these years, industrial growth could be mostly accommodated by existing unused capacity. By 1995 the NSPS control would begin to have a slight effect, primarily due to the NSPS for electric furnaces in the iron and steel industry.

Fugitive Emissions. It should be noted that neither the SIP nor the NSPS control factors account for fugitive emissions. As seen in Table 2-6, fugitive emissions are only a fraction of the uncontrolled stack emissions. However, as SIP compliance on stack emissions is effected, fugitive emissions gain relative importance and begin to dominate.

Other Control. The phasedown of lead in gasoline not only directly relates to lead emissions from mobile sources, but also affects lead emissions from point sources which burn waste crankcase oil. As the lead content of gasoline is reduced, the lead content of waste crankcase oil will also decline and the resulting lead emissions from the stationary combustion of waste crankcase oil (i.e., in coal-fired power plants, oil-fired power plants, and municipal incinerators) would be expected to decrease proportionally.

2.2 Ambient Lead Concentrations

Current levels of airborne lead concentrations in the United States are important in determining the potential for air quality improvement required to meet a proposed ambient lead standard. The feasiblity of attaining and maintaining a given standard, and the impact of implementing that standard, depend on the required changes in air quality relative to present levels. Concentrations of airborne lead have been routinely monitored by a variety of Federal, state and local agencies in a number of Air Quality Control Regions (AQCR's) throughout the United States in recent years, although the reporting and monitoring procedures are not standardized and often result in inconsistent data (e.g., data based on nonuniform averaging times). This type of monitoring information is discussed in Section 2.2.1.

In addition to routine air quality monitoring conducted in an AQCR, a number of special monitoring studies have been undertaken in the immediate vicinity of particular stationary lead emission sources. This information, presented in Section 2.2.2, is useful in analyzing the different types of point sources and determining the important factors that contribute to high ambient lead levels.

For those AQCR's in which there are not routine lead monitoring data available, estimates of air quality can be made based on airborne lead emissions from existing typical point and mobile sources. Section 2.2.2 presents the results of this estimation process, where the highest expected lead concentrations are determined from maximum point source emission rates and highest traffic counts in the different AQCR's.

2.2.1 Network Monitoring Data

Ambient air lead concentration data are collected by a number of Federal, state, local and private agencies. In 1974, the National Air Surveillance Network (NASN) and the National Aerometric Data Bank (NADB) included lead monitoring data from 127 of the 247 AQCR's, and in 1975 there were 148 AQCR's represented in the data systems. In August 1976 a telephone survey was made to air monitoring agencies having responsibilities in the remaining AQCR's in the contiguous United States which were not represented in the NASN and NADB files (eight AQCR's in Alaska, Hawaii, American Samoa, Guam, and the U.S. Virgin Islands were not contacted). This survey found that lead monitoring in 33 additional AQCR's has been accomplished to date.

The total number of AQCR's with 1974 data was 144, while a total of 162 AQCR's had 1975 lead concentration data (including 2 with 1976 data). For all years combined (effectively 1974 and 1975) there were 170 AQCR's with reported monitoring data. Many of the monitoring agencies did not report their measured lead concentration data to the NASN or NADB systems due to a failure to understand the reporting procedures for lead, the relatively low values observed, or other undisclosed reasons.

The concentration data contained in the NASN and NADB systems were reported in terms of 24-hour measurements averaged over a calendar quarter, while other averaging times such as a year, were used as the basis for data reported by some state and local monitoring agencies. In order to compare concentration, all measurements were converted to monthly averaging times. In some cases, quarterly averages were not reported in the NASN or NADB systems because the data were "insufficient;" that is, there were fewer than five 24-hour measurements during a quarter, or there was no more than one measurement during any two months of a quarter.

Monthly averages were determined for all 170 AQCR's with reported lead concentrations, even those with "insufficient" data, data reported in terms of different averaging times, or data from years other than 1974 and 1975. In order to compare measured lead concentrations with an ambient standard based on a monthly averaging time, maximum concentrations for other averaging times were converted to maximum monthly concentrations.

Table 2-8 indicates the maximum monthly mean for all AQCR's with at least one value exceeding 1.0 $\mu g/m^3$. In all, 120 AQCR's (49 percent of all regions) are presented in the table. High ambient lead concentrations usually are restricted to the vicinity of a lead emitter; hence, an average concentration measurement for all monitors in AQCR is less indicative of potential problems than maximum concentration values. However, the pervasiveness of high levels of airborne lead may be impossible to determine because of the distribution of monitoring sites. For example, there may be only one major emitter in an AQCR, and all monitoring sites are clustered around it, while the rest of the AQCR has very low levels of airborne lead. Nevertheless, an analysis of the ambient lead concentration summary given in Table 2-4 can given an indication of which AQCR's have potential problems due to high lead concentrations.

Of the 120 AQCR's represented in Table 2-4, 78 had monthly mean lead concentrations of 1.5 $\mu g/m^3$ or above, 49 had concentrations of 2 $\mu g/m^3$ or above, 23 had at least one monthly mean of 2 $\mu g/m^3$ or greater, and 12 had concentrations above 4 $\mu g/m^3$. There are a number of examples of the correlation between particular lead emitters and nearby elevated concentrations of lead, but it is extremely difficult to estimate the percent contributed from each emitter to a particular receptor. A review of the major sources of

TABLE 2-8

MAXIMUM MONTHLY LEAD CONCENTRATIONS FOR SELECTED AQCR'S ①

AQCR NUMBER	LOCATION	MAXIMUM MONTHLY MEAN	
		VALUE ($\mu g/m^3$)	YEAR
2	AL/GA	1.73	1974
3	E. AL	1.64	1975
4	W. AL	2.55	1975
5	FL/MS/AL	2.00	1974
7	TN/AL	1.29	1975
8	S. AK	1.51	1974
9	N. AK	2.34	1975
13	NV/AZ	2.72	1974
14	AZ/CO/NM/UT	4.73	1974
15	S. AZ	5.13	1974
16	CENT. AR	1.35	1974
18	AR/MS/TN	2.91	1975
22	AR/LA/OK/TX	1.10	1975
24	S.W. CA	7.77	1974
28	N. CA	3.68	1974
29	S. CA	4.32	1975
30	W. CA	3.14	1975
31	CENT. CA	3.01	1975
33	S.E. CA	1.04	1975
36	CENT. CO	2.29	1975
42	CT/MA	3.16	1975
43	NJ/NY/CT	2.51	1974
45	DE/NJ/PA	2.41	1974
47	DC/MD/VA	1.76	1975
49	FL/GA	1.62	1975
50	S.E. FL	3.56	1974
52	W. FL	3.18	1974
53	GA/SC	1.16	1974-75
54	CENT. GA	2.20	1974
55	GA/TN	1.44	1975
56	W. GA	2.55	1975
57	N.E. GA	1.04	1974
58	GA/SC	1.62	1975
59	S.W. GA	1.16	1974
60	HI	1.07	1974
62	ID/WA	37.06	1974
65	IL/IA	1.38	1975
67	IL/IN	4.00	1975

TABLE 2-8 (continued)

MAXIMUM MONTHLY LEAD CONCENTRATIONS FOR SELECTED AQCR'S ①

AQCR NUMBER	LOCATION	MAXIMUM MONTHLY MEAN	
		VALUE ($\mu g/m^3$)	YEAR
69	IL/IA	1.37	1975
70	IL/MO	1.83	1975
73	IL/WI	1.27	1974
76	E. IN	1.38	1975
78	KY/IN	1.54	1974
79	KY/IN/OH	1.20	1975
80	CENT. IN	1.40	1974
82	IN/MI	1.61	1974
83	S. IN	6.18	1974
84	W. IN	1.03	1974
85	IA/NE	1.25	1975
88	N.E. IA	1.19	1975
92	S. IA	1.56	1975
94	MO/KS	1.69	1974
101	S.E. KY	2.52	1975
102	CENT. KY	1.47	1975
103	KY/OH/WV	2.41	1974
104	CENT. KY	3.56	1975
106	LA/TX	1.98	1974
109	E. ME	1.04	1974
113	MD/WV	1.10	1974
115	N. MD	4.15	1975
116	S. MD	2.40	1974
118	CENT. MA	1.12	1975
119	E. MA	1.37	1975
120	MA/RI	1.60	1975
122	CENT. MI	1.47	1975
123	E. MI	2.17	1974
124	MI/OH	1.03	1975
125	S. MI	1.04	1974
128	S.E. MN	1.69	1975
129	MN/WI	1.25	1974
131	CENT. MN	4.10	1975
136	N. NC	1.47	1975
139	S.W. MO	3.67	1974
141	N. MT	1.11	1972
142	S.W. MT	4.66	1972
148	W. NV	1.85	1975

TABLE 2-8 (continued)

MAXIMUM MONTHLY LEAD CONCENTRATIONS FOR SELECTED AQCR'S ①

AQCR NUMBER	LOCATION	MAXIMUM MONTHLY MEAN	
		VALUE ($\mu g/m^3$)	YEAR
151	PA/NJ	3.35	1974
152	CENT. NM	1.69	1974
153	NM/TX	3.08	1975
158	CENT. NY	1.60	1974
159	NY/VT	1.42	1974
160	CENT. NY	3.79	1975
161	E. NY	3.12	1974
162	W. NY	1.24	1975
166	N. NC	1.67	1975
167	NC/SC	1.49	1975
173	W. OH	1.16	1975
174	N. OH	1.54	1974
176	CENT. OH	1.38	1975
178	OH/PA	1.89	1974
181	OH/WV	1.03	1975
184	CENT. OK	3.65	1974
193	OR/WA	1.38	1974
195	CENT. PA	1.82	1974
196	S. PA	1.68	1974
197	S.W. PA	5.08	1974
200	CENT. SC	2.12	1974-75
202	N.W. SC	2.10	1975
207	TN/VA	1.86	1975
208	CENT. TN	2.07	1974
209	W. TN	1.23	1975
211	N.W. TX	1.71	1975
212	CENT. TX	1.04	1975
214	S.E. TX	1.39	1975
215	N. TX	3.95	1975
216	E. TX	2.79	1975
217	S.W. TX	1.55	1974
218	W. TX	5.74	1974
220	W. UT	1.26	1975
221	E. VT	2.22	1974
222	S. VA	1.23	1975
223	S.E. VA	1.52	1975
225	CENT. VA	1.84	1974
226	N.W. VA	1.68	1974

TABLE 2-8 (concluded)
MAXIMUM MONTHLY LEAD CONCENTRATIONS FOR SELECTED AQCR'S ①

AQCR NUMBER	LOCATION	MAXIMUM MONTHLY MEAN	
		VALUE ($\mu g/m^3$)	YEAR
229	CENT. WA	2.56	1974
234	W. WV	1.44	1975
237	N.E. WI	1.04	1974
239	S.E. WI	3.21	1974
240	S. WI	1.88	1974
244	PR	2.68	1974

1. Selected AQCR's are those with an estimated maximum monthly concentration exceeding 1.0 $\mu g/m^3$.

Source: See Appendices P, Q, and R.

lead emissions in the 12 AQCR's with maximum monthly concentrations above 4 $\mu g/m^3$ reveals specific types of situations which can lead to relatively high ambient lead levels. Most of the monthly values are estimates based on reported anbient concentrations for other averaging times.

The Eastern-Washington-Northern Idaho Interstate AQCR (No. 62) has the highest proportion of ambient concentrations above 4 $\mu g/m^3$ of all AQCR's (U.S. Environmental Protection Agency, 1974h, i; U.S. Environmental Protection Agency, 1975h, i). Near the monitoring sites is the Bunker Hill lead smelter in Kellogg, Idaho, which emits up to 83 tons per day of lead into the atmosphere (U.S. Environmental Protection Agency, 1974f: PEDCo-Environmental Specialists, Inc., 1976). The presence of this lead smelter, and possibly the presence of three cast iron foundries, contribute to the relatively high concentrations of airborne lead that were measured in AQCR 62.

Other types of major lead emission sources can also be cited as possible reasons for high values of airborne lead recorded in an AQCR. For exmaple, the presence of five primary copper smelters in Southern Arizona is probably a major cause of the elevated ambient lead concentrations in AQCR 15 (viz., a maximum estimated monthly value of 5.1 $\mu g/m^3$). In addition to the copper smelters, seven-oil fired power plants, three cast iron foundries, and a battery plant represent other stationary sources of lead in the AQCR, while the presence of high traffic volumes and the resulting lead emissions from car exhausts is indicated by the fact that this area (Phoenix in particular) has a transportation plan to control vehicular emissions.

Primary lead and copper smelters also have contributed to elevated lead levels in AQCR 142 in Southwestern Montana, where maximum 24-hour measurements ranged up to 15 $\mu g/m^3$ (State Department of Health and Enviromental Sciences, Montana, 1972). Two cast iron foundries and a ferroalloy producer also may have had some impact on the observed values.

Cast iron foundries are the major sources of lead emissions in AQCR 218, Western Texas, where the maximum estimated monthly lead concentration was 5.7 $\mu g/m^3$. While vehicular emissions and small stationary sources contribute to the overall ambient lead concentrations, the four foundries are probably the major lead emitters in this AQCR.

In the Four Corners Region of Arizona, New Mexico, Utah, and Colorado (AQCR 14), the maximum estimated monthly concentration was over 4 $\mu g/m^3$. The major sources of lead emissions in this area are six coal-fired power plants. This is another example of an AQCR where lead concentrations are primarily caused by one type of source.

In contrast, the Los Angeles region in Southwestern California (AQCR 24) is an area where a number of different source types contribute to the high lead concentrations, which range up to a maximum estimated monthly value of 7.8 $\mu g/m^3$ (Air Resources Board, California, 1975). Emissions from a number of battery plants, secondary lead smelters, cast iron foundries, oil-fired power plants, in addition to the large number of mobile sources, combine to produce the measured airborne lead levels.

The San Diego region (AQCR 29) is similar to the Los Angeles region, only on a smaller scale. Two battery plants, a similar number of cast iron foundries, and four oil-fired power plants helped contribute to the estimated maximum monthly lead concentration of 4.3 $\mu g/m^3$.

All other AQCR's with maximum quarterly means about 4 $\mu g/m^3$ have various types of major lead emitters which contribute to the potential airborn lead problem. Cast iron foundries and a coal-fired power plant are the major sources of airborne lead in Southern Indiana (AQCR's 83), where the maximum estimated monthly concentration was 6.2 $\mu g/m^3$.

Cast iron foundries represent the largest number of stationary lead emission sources in Pittsburgh and Southwestern Pennsylvania (AQCR 197). In addition, there are ferroalloy producers, battery plants, coal-fired power plants, a secondary lead smelter, a municipal incincerator, and an oil-fired power plant in the AQCR, plus a relatively large number of mobile sources as evidenced by the fact that Pittsburgh has a transportation plan to control vehicular emissions. The maximum quarterly mean lead concentration in AQCR 197 was 5.1 $\mu g/m^3$.

The Chicago region (AQCR 67) includes a relatively large number of different lead emission sources, such as battery plants, secondary lead smelters, cast iron foundries, municipal incinerators, coal and oil-fired power plants, and mobile sources. The resulting estimated monthly level was 4.0 $\mu g/m^3$.

The other two AQCR's with concentrations above 4 $\mu g/m^3$ are located in Northern Maryland (AQCR 115, 4.2 $\mu g/m^3$ maximum monthly value), and in Central Minnesota (AQCR 131, 4.1 $\mu g/m^3$ estimated maximum monthly concentrations). Each AQCR has a few battery plants, secondary lead smelters, and coal-fired power plants. In addition, AQCR 115 has six cast iron foundries, a municipal incinerator, and five oil-fired power plants, while AQCR 131 has 14 cast iron foundries. Each AQCR also has a mobile source plant to help control vehicular emissions.

Maximum estimated monthly lead concentration in the 170 AQCR's for which monitoring data have been received indicates the extent of potential problems due to airborne lead, as defined by three different levels of airborne lead concentrations, 1.0, 1.5 and 2.0 $\mu g/m^3$ for maximum monthly averages.

Figure 2-3 shows the number of AQCR's that have at least one maximum monthly concentration above each of the indicated levels in 1974 and 1975. In a few instances, 1972 data were combined with 1974 results and 1976 data augments 1975 information. In all but one case (viz., monthly values above 1.0 $\mu g/m^3$), the number of AQCR's with

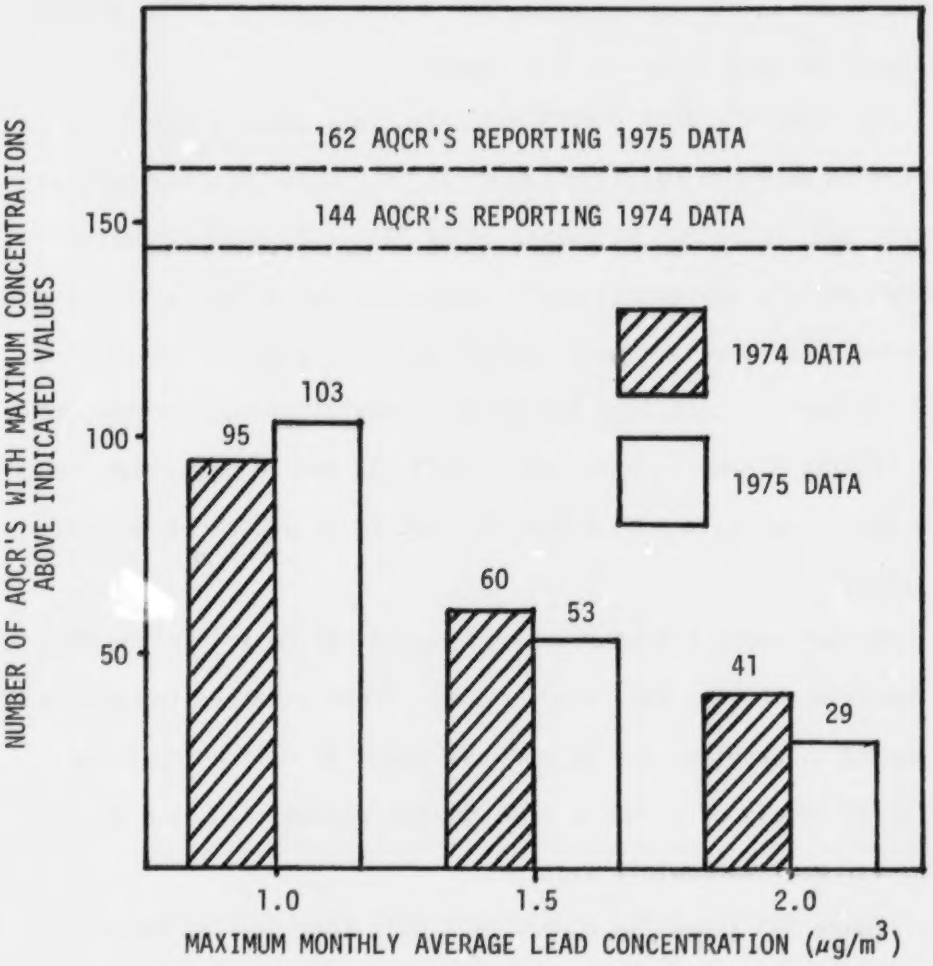

FIGURE 2-3
NUMBER OF AQCR'S WITH MAXIMUM MONTHLY CONCENTRATIONS
ABOVE INDICATED VALUES

maximum monthly concentrations above a certain level decreased from 1974 to 1975. In all cases, however, the percentages of AQCR's with data that had quarterly concentrations above a given level declined from 1974 to 1975. Thus, while eight more AQCR's reported monthly values above 1.0 $\mu g/m^3$ in 1975 than in 1974, there was a 2.4 percent decrease from 1974 to 1975 in the percentage of AQCR's that reported lead monitoring data and had monthly values above 1.0 $\mu g/m^3$. These declines appear to signify a relative improvement in air quality with respect to airborne lead from 1974 to 1975, due possibly to the reduction of the lead content in gasoline as well as the installation of particulate control devices on stationary sources over the years.

At a limit of 1.0 $\mu g/m^3$, 120 of the 170 AQCR's with available data (71 percent) had estimated monthly lead concentrations exceeding this value. The number of AQCR's decreases to 77 (46 percent of those reporting data) with monthly levels above 1.5 $\mu g/m^3$, and to 48 (29 percent) that have at least one monthly concentration above 2.0 $\mu g/m^3$. Geographically, the 120 AQCR's which have maximum monthly lead concentrations above 1.0 $\mu g/m^3$ comprise the majority of land area of the country and include the heavily populated areas.

Figure 3-1 shows the number of AQCR's which would have been out of compliance relative to different proposed standards based on reported ambient air concentrations for 1975 alone. Out of the 162 AQCR's with reported data, almost 64 percent reported ambient air concentrations greater than 1.0 μg/m^3, while only 18 percent would have been out of compliance for a standard of 2.0 μg/m^3.

2.2.2 Source Specific Data

Empirical studies have been conducted in order to investigate the ambient air concentrations of airborne lead in the vicinity of various stationary lead emission sources. However, because of the number of different factors which can influence ambient lead concentrations, the relationship between a particular lead emission source and the resultant ambient lead levels can only be determined in a general way. Influencing factors include meteorological variables such as wind speed and direction, stability class, and ambient temperature; source-related factors such as stack height, fugitive emissions, operating schedules (e.g., plant shutdowns), and source type; terrain factors such as topography, local building sizes, and nearby vegetation types, location factors such as downwind distance, urban environmental, and other proximate emission source height, and monitoring equipment condition. No single factor is responsible for the concentrations observed at various downwind locations near an emission source; hence, it is difficult to extrapolate the reported data to ambient lead concentrations around other sources of airborne lead. Nevertheless, empirical studies of ambient lead concentrations near certain industries can provide insight into the general relationships between lead emissions and downwind concentrations.

2.2.2.1 Specific Source Analysis. Primary Lead Smelters. Ambient air quality measurements conducted in the vicinity of three primary lead smelters showed relatively high lead concentrations when compared to other lead emission sources. The American Smelting and Refining company (ASARCO) smelter in East Helena, Montana is the smallest of the three, producing an average of 170 tons of lead a day. The Bunker Hill smelter in Kellogg, Idaho is the largest, with a daily production of 350 tons of lead, while another ASARCO smelter in El Paso, Texas produces 200 tons of lead as well as 260 tons of copper a day (U.S. Environmental Protection Agency, 1975g).

The means of the monthly lead concentrations for ten receptors in the vicinity of the El Paso smelter range from 10.2 $\mu g/m^3$ at the closest receptor (0.2 mile away) to 0.9 $\mu g/m^3$ at the most distance receptor (3.7 miles away). Receptors located more than 1.1 miles (1.8 kilometers) from the smelter had no monthly lead concentrations greater than 5 $\mu g/m^3$, while the average of the monthly concentrations at any receptor was never more than 1.8 $\mu g/m^3$. Also, no monthly concentration exceeded 3 $\mu g/m^3$, and no average of the monthly concentrations exceeded 0.9 $\mu g/m^3$ for receptor sites more than three miles (4.8 kilometers) from the smelter.

The Bunker Hill lead smelter in Kellogg, Idaho processes 75 percent more lead per day than is processed by the ASARCO smelter in El Paso. The maximum 24-hour lead concentation between March 1973 and June 1974 at a monitoring site 2,500 feet (760 meters) southeast of the mainstack was 45.5 $\mu g/m^3$, while the average 24-hour value was 12.5 $\mu g/m^3$. The distribution of daily concentrations at a receptor 0.4 mile from the Bunker Hill smelter shows a larger percentage of values above 5 $\mu g/m^3$ when compared to the concentration distribution at the closest receptor to the ASARCO-El Paso smelter (86 versus 61 percent, respectively), in spite of the fact that the downwind distance to the El Paso receptor is smaller (0.2 mile). The annual mean concentration at the receptor near the Bunker Hill smelter (12.5 $\mu g/m^3$) is also larger than at the El Paso receptor (10.2 $\mu g/m^3$). This is probably because the Kellogg plant emits more lead due to a number of factors, including a higher rate of lead processing, a higher concentration of lead in the ore, and slightly less efficient control devices.

Ambient lead concentrations have been monitored near the ASARCO lead smelter by the Environmental Protection Agency in 1975. Only maximum 24-hour values were reported, and these showed a general inverse relationship between concentration and distance from the source. The three receptors within one mile of the smelter averaged 12.1 $\mu g/m^3$ as a 24-hour maximum, while the two receptors 2.5 and 4.5 miles from the smelter had 2.5 and 7.0 $\mu g/m^3$ maximums, respectively.

Primary Copper Smelters. Primary copper smelters also produce lead as a byproduct, some of which is emitted to the effluent stream.

In general, lead concentrations in the vicinity of primary copper smelters are lower than those in the vicinity of lead smelters because of the lower uncontrolled lead emissions per ton of product from copper smelters.

Ambient lead levels around the Anaconda copper smelter in Anaconda, Montana were measured in 1973 and 1974. This is the largest of the copper smelters investigated, processing 500 tons of copper a day (U.S. Environmental Protection Agency, 1974f). The mean of the measured 24-hour lead concentration was 0.2 $\mu g/m^3$, with no values exceeding 0.6 $\mu g/m^3$. These concentrations were much lower than the ambient levels around the lead smelters described previously due to the lower lead emissions, the generally greater distance to the receptor, and the very tall stack (925 feet).

The Kennecott copper smelter in McGill, Nevada is smaller than the Anaconda plant, processing only 190 tons of copper per day (U.S. Environmental Protection Agency, 1974f). The average 24-hour ambient lead concentration 2.6 miles from the smelter was 0.3 $\mu g/m^3$, which was much lower than similar measurements observed near the three lead smelters described previously, even for receptors greater than 2.6 miles from their respective smelters.

The Magma copper smelter in San Manuel, Arizona processes 310 tons of copper per day, with a mean 24-hour lead concentration of only 0.07 $\mu g/m^3$, far less than the average values around the primary lead smelters described above, while no concentration exceeded 0.7

μg/m^3. In spite of the fact that the quantity of copper processed at the San Manuel smelter is greater than the amount at the McGill smelter, and the receptor was closer (0.9 mile versus 2.6 miles), the airborne lead levels were lower. This was probably due in part to the taller stack and the high efficiency of the particulate control methods used at the San Manuel smelter.

The Phelps Dodge copper smelter in Ajo, Arizona processes 200 tons per day of copper (U.S. Environmental Protection Agency, 1974f), while the average 24-hour measured lead concentration near the smelter was 0.06 μg/m^3. Another Phelps Dodge copper smelter, in Douglas, Arizona, processes 370 tons of copper per day (U.S. Environmental Protection Agency, 1974f) with an average 24-hour concentration of 0.2 μg/m^3, and maximum concentration of 1.3 μg/m^3 at the receptors 3.1 miles from the smelter.

All receptors greater than 0.4 mile from the lead and copper smelters had 58 percent or more of their monthly lead concentrations below the level of 2 μg/m^3. If receptors near the El Paso and Kellogg smelters are excluded from the analysis, then over 94 percent of the 24-hour concentrations at all other receptors were less than 1 μg/m^3.

Lead Storage Battery Plants. Ambient lead monitoring has been conducted in the vicinity of five battery plants by Pennsylvania's Department of Environmental Resources. Four of the plants investigated combine grid manufacturing with secondary smelting of reclaimed lead from used batteries. The secondary lead smelting facilities of the General Battery plant in Hamburg, Pennsylvania were removed in April 1971; ambient lead concentrations were monitored both before and after the operational change.

The Marjol Battery Company plant in Throop, Pennsylvania processes an average of 3.7 and a maximum of 3.8 tons of lead per hour. Measured ambient concentrations ranged up to 4.9 $\mu g/m^3$ for an average of all 24-hour values at one receptor, while at another receptor over 35 percent of the observations were above 5 $\mu g/m^3$, both receptors being 330 yards from the plant. This fact probably results from the relatively small stack height of the battery plant (20 feet) and the proximity of the receptors (0.19 mile).

Lead emissions from the General Battery Company in Hamburg, Pennsylvania are reported to average 1.1 pounds/hour with a maximum of 1.6 pounds/hour for the grid casting operations without a reverberatory furnace. Existing control equipment includes a baghouse with a 98 percent designed particulate removal efficiency and a scrubber with a 96 percent design efficiency (Department of Environmental Resources, Pennsylvania, 1976b). Prior to April 23, 1971, when the reverberatory furnace at the plant was removed, ambient lead concentrations near the plant were extremely high, with average 24-hour values up to 56.5 $\mu g/m^3$ at a distance of 50 yards (46 meters), and a maximum 24-hour value of 160 $\mu g/m^3$ at a receptor 275 yards (251 meters) away. Current lead concentrations at these same two receptors are 2.5 $\mu g/m^3$ (average 24-hour value) and 2.9 $\mu g/m^3$ (maximum 24-hour value), respectively.

The General Battery Company plant in Laureldale, Pennsylvania, employs a total of eight smelting and casting operations, and emits an average of 4.9 pounds of lead per hour and up to a maximum of 7.3 pounds per hour. Average 24-hour lead concentrations measured in 1971 at three monitors within 250 yards (230 meters) of the plant were no greater than 1.5 $\mu g/m^3$, with no single 24-hour value exceeding 3.2 $\mu g/m^3$. However, in 1975 the average 24-hour lead concentrations at two monitors 150 yards from the plant were 15.2 and 33.2 $\mu g/m^3$ with maximum 24-hour values of 72 $\mu g/m^3$ and 140 $\mu g/m^3$, respectively (these higher values probably reflect increased lead emissions which were reduced by 1971). The reported concentrations at the Laureldale plant were measured prior to the addition of a lead reverberatory furnace that was moved from the Hamburg plant of the General Battery Corporation.

The Prestolite Battery Division of the Eltra Company in Temple, Pennsylvania emits a total of 9.7 pounds of lead per hour from 13 different processing operations. Average 24-hour ambient concentrations near the plant generally decline with increasing distance, from 8.2 to 1.3 $\mu g/m^3$ for receptors from 25 to 250 yards (23 to 230 meters) from the plant. However, the two closest monitoring sites are near a heavily traveled road where lead emissions from traffic may be important contributors to overall concentration levels.

Another receptor 1,330 yards (1,210 meters) away recorded an average concentration of 2.7 $\mu g/m^3$ in 1970, but this level was influenced by the lead emissions from the nearby General Battery plant in Laureldale.

The East Penn Battery Plant incorporates a blast furnace with potential lead emissions of 237 pounds/hour. The average 24-hour ambient lead concentrations, measured from 250 to 300 yards (230 to 270 meters) away, ranged from 3.1 to 3.9 $\mu g/m^3$.

Secondary Lead Smelters, Ferroalloy Producers, and Gray Iron Foundries. Ambient lead concentrations near the property line of secondary lead smelters, ferroalloy manufacturers, and gray iron foundries have been measured by the Texas Air Control Board. Sample 24-hour lead concentrations ranged from 3.3 to 111.6 $\mu g/m^3$ near two secondary lead smelters, from 2.5 to 4.2 $\mu g/m^3$ near a ferroalloy producer, and from zero to 50.9 $\mu g/m^3$ near seven gray iron foundries. Unfortunately, the relatively small number of reported samples and the lack of precise information concerning source emissions tend to reduce the significance of the data when compared to the ambient data presented for other source types.

A study was conducted between May and December 1973 by the Toronto Board of Health of lead concentrations near two secondary lead smelters (Roberts et al., 1974). It was found that fugitive emissions were more important than stack emissions in contributing to the nearby ambient lead levels, primarily because of the lower emissions heights of fugitive sources. A comparison was made of ambient lead concentrations near the smelters with concentrations in an urban control area away from the smelters to see if there were any significant differences that could be attributed to lead emissions from the smelters. It was found that the geometric mean lead concentration in the smelter area was 3.0 $\mu g/m^3$ compared to a similar mean of 0.8 $\mu g/m^3$ in the urban control area (Roberts et al., 1974).

2.2.2.2 General Considerations. Ambient lead concentrations in the vicinity of certain industrial plants are the result of a number of variables. In general, the data demonstrate some important relationships such as the direct relationship between concentrations and the lead emission rate, and the inverse relationship between downwind distance and ambient levels of lead. Figures 2-4, 2-5, and 2-6 depict maximum 24-hour ambient lead concentrations as a function of distance from primary and secondary lead smelters (Figure 2-4), primary copper smelters and gray iron foundries (Figure 2-5), and battery plants (Figure 2-6). Lead concentrations near primary lead smelters (Figure 2-4) show most clearly the general decline of lead levels at increasing downwind distances from an emission source.

Table 2-9 indicates the percentage of monthly concentrations which exceeded five different concentration levels in the vicinity of the industrial plants investigated. In some cases, general conclusions concerning ambient lead concentrations near certain types of stationary emission sources may be drawn based on previous discussions.

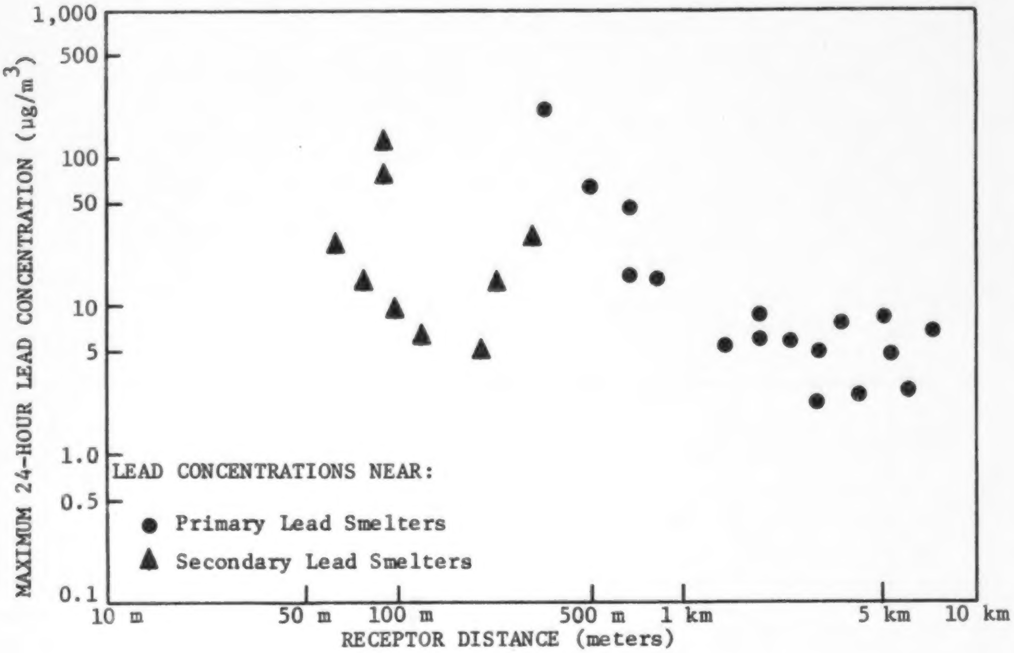

FIGURE 2-4
LEAD CONCENTRATIONS VERSUS DISTANCE FROM
PRIMARY AND SECONDARY LEAD SMELTERS

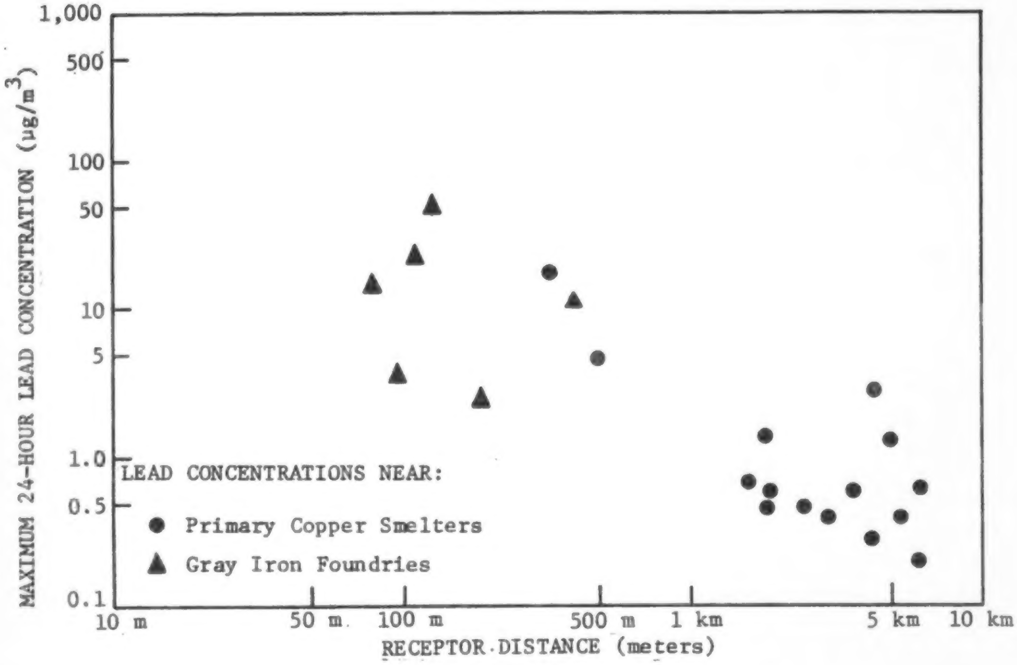

FIGURE 2-5
LEAD CONCENTRATIONS VERSUS DISTANCE FROM
PRIMARY COPPER SMELTERS AND GRAY IRON FOUNDRIES

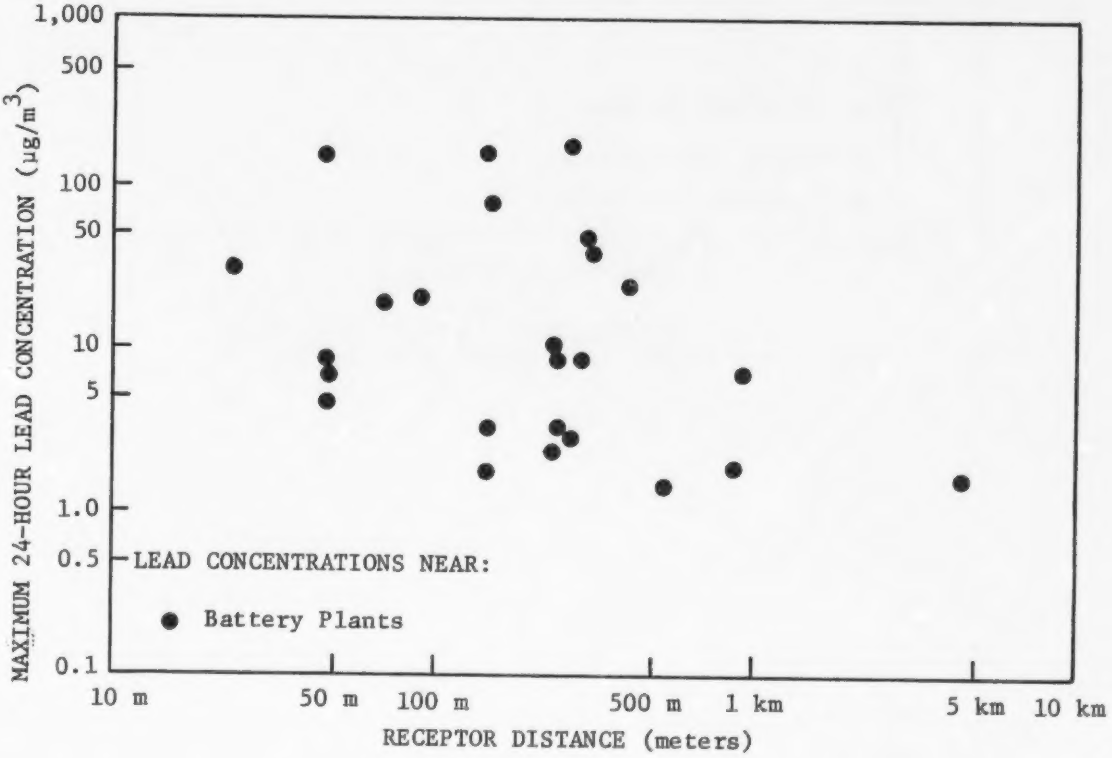

FIGURE 2-6
LEAD CONCENTRATIONS VERSUS DISTANCE FROM BATTERY PLANTS

TABLE 2-9

PROBABILITY OF EXCEEDING LEAD CONCENTRATION LEVELS NEAR SELECTED INDUSTRIES

INDUSTRY AND PLANT	PERCENTAGE OF MONTHLY AVERAGES EXCEEDING GIVEN LEVELS (g/m^3)					NUMBER OF MONTHLY AVERAGES
	0.5	1.5	2.0	3.0	5.0	
PRIMARY LEAD SMELTER						
ASARCO--El Paso, TX	96	49	35	20	13	379
Bunker Hill--Kellogg, ID	100	100	100	100	87	16
ASARCO--East Helena, MT	27	0	0	0	0	15
PRIMARY COPPER SMELTER						
ASARCO--El Paso, TX	96	49	35	20	13	379
Anaconda--Anaconda, MT	0	0	0	0	0	9
Kennecott--McGill, NV	7	0	0	0	0	14
Magma--San Manual, AZ	0	0	0	0	0	11
Phelps Dodge--Ajo, AZ	0	0	0	0	0	10
Phelps Dodge--Douglas, AZ	0	0	0	0	0	12
LEAD BATTERY MANUFACTURER						
Marjol Battery--Throop, PA	93	60	47	30	17	101
General Battery--Hamburg, PA	100	100	100	57	0	7
General Battery--Laureldale, PA	100	79	79	64	57	14
Prestolite Battery--Temple, PA	100	92	67	67	33	12
East Penn--Richmond Township, PA	100	100	100	100	0	3
SECONDARY LEAD SMELTER (a)						
Dixie Lead--Dallas, TX	100	100	100	100	100	1
NL Industries--Dallas, TX	100	100	100	100	100	1
FERROALLOY PRODUCER (a)						
Tenn-Tex Alloy--Houston, TX	100	100	100	100	0	1
GRAY IRON FOUNDRY (a)						
Oil City Iron Works--Corsicana, TX	0	0	0	0	0	1
Lufkin Industries--Lufkin, TX	100	100	100	100	100	1
Tyler Pipe--Tyler, TX	100	0	0	0	0	1
Trinity Valley Iron and Steel--Fort Worth, TX	100	100	100	0	0	1
Green's Bayou Foundry--Houston, TX	100	100	100	100	100	1
McKinley Iron Works--Fort Worth, TX	100	100	100	100	100	1
American Darling Foundry--Beaumont, TX	100	100	100	100	100	1

Note: (a) Percentages are based on the one monthly average ambient air lead concentration value available for each plant listed.

Sources: U.S. Environmental Protection Agency. 1974g. Smelter Study, 1973-1974.

Department of Environmental Resources, Pennsylvania. 1976a. Hi-Vol Sampling Data.

Texas Air Control Board. April 1974a. A Report of Typical Element Emissions from Texas Smelters. Austin, Texas.

Texas Air Control Board. April 1974b. A Report of Typical Element Emissions from Texas Foundries. Austin, Texas.

High ambient lead levels were observed in the vicinity of primary lead smelters and battery plants, particularly those which include secondary lead smelting facilities, and may be expected in the vicinity of other, similar plants. These results are mainly due to the relatively large lead emissions from the primary lead smelters, and the apparent lack of atmospheric dispersion at the battery plants/secondary smelters due to relatively small source-receptor distances and stack heights. Concentrations in the vicinity of primary copper smelters were not as high because of their comparatively large stack heights. However, in some cases ambient lead concentrations could show elevated values because of downwash or fumigation conditions from the stack, and the amount of fugitive lead emissions from this type of facility. A large percentage of the lead emissions from copper smelters is due to fugitive emissions, which produce maximum downwind concentrations relatively near the plant site and much closer than the monitoring sites used for the reported air quality studies. If all monitoring sites were located at the point of maximum downwind concentration from each emission source, primary lead and copper smelters would probably produce higher ambient lead concentrations than battery plants or other types of sources.

2.2.3 Estimated Ambient Lead Levels for AQCR's Without Monitoring Data

2.2.3.1 Introduction. For 74 of the 78 Air Quality Control Regions (AQCR's) with lead air quality data for 1975, estimates of the maximum monthly lead levels have been determined through mathematical modeling of lead emissions and subsequent atmospheric diffusion patterns (the four AQCR's omitted from the analysis were outside the continental United States). Maximum lead emissions were estimated from mobile sources at the location of the highest recorded daily traffic volume within each AQCR. A line source diffusion model was then applied to estimate the resulting ambient lead concentration ten meters downwind from the road or street, given the observed traffic speeds and road conditions. Emissions from stationary sources were estimated by applying appropriate emission factors and control efficiencies to each size and type of major lead source known to exist in an AQCR. Maximum downwind concentrations were then estimated for each source from diffusion equations, given appropriate stack and fugitive emission parameters. The highest monthly lead concentration from a stationary source was then superimposed on the maximum concentration from mobile sources in each AQCR to derive the expected upper limit for ambient lead levels. Because of the uncertainties involved in estimating lead concentrations, the use of the expected upper limit as a design value for determining emission rollback requirements tends to minimize the probability of underestimating the impact of alternative lead standards.

2.2.3.2 Concentration Estimates from Mobile Sources. Each AQCR within the continental United States which did not have reported lead concentrations was contacted in order to determine the maximum average daily traffic count (ADT) in that AQCR and the location of that count. The type of road and its location were noted in order that the correct line source diffusion model classified according to one of four different roadway configurations could be applied.

The location and condition of each roadway where the maximum ADT was observed permitted a classification according to one of the four following configurations.

(1) outside an urban area; limited access; free traffic flow (60 miles/hour average speed);

(2) within influence of an urban area; limited or nonlimited access; somewhat restricted traffic flow (48 miles/hour average speed);

(3) within an urban area; limited or nonlimited access; moderately congested traffic flow (38 miles/hour average speed);

(4) within an urban central business district; nonlimited access; heavily congested traffic flow (16 miles/hour average speed).

The lead emissions rate per vehicle for each of these roadway configurations was based on the average lead content of gasoline and the average fuel economy considering traffic speeds. Lead content was assumed constant for all configurations, and equals 1.69 g Pb/gallon based on gasoline usage requirements in 1975 (see Section 2.1.1.3). The average fuel economy, determined from traffic speeds for the different configurations and the age distribution of vehicles in 1975, varied from 10.2 miles/gallon (mpg) for Configuration 4 to 21.4 mpg for Configuration 2. The emission rate, in g/m-sec, was determined from these variables plus the traffic count, and then converted to a downwind concentration by use of a line source diffusion model. Table 2-10 shows the resulting maximum monthly ambient lead concentration for mobile sources in each of the indicated AQCR's.

2.2.3.3 Concentration Estimates from Stationary Sources. An inventory of the size and type of nine stationary sources of airborne lead was used to estimate lead emissions in those AQCR's without monitoring data. Appropriate emission factors and control requirements* were applied to the output levels of typical plants representing the different major industries with lead emissions. Each resulting lead emission rate, Q in (tons/year), was then related to a maximum monthly lead concentration, χ(in μg/m^3), by use of an atmospheric diffusion model (Scruggs, 1977). The model was run for different industry types, and in some cases for different sizes, because of the varying stack parameters and other variables which affect pollutant diffusion. A separate factor, χ/Q, was developed for each typical plant type and then multiplied by Q for the largest plant of each category in each of the pertinent AQCR's. The resulting monthly downwind concentrations, representing the maximum ambient lead levels in the vicinity of the different industry categories in each AQCR, are shown in Table 2-10.

The sum of the maximum expected concentration from the largest stationary contributor and the concentration near the roadway with the highest traffic count is used as an upper limit of the expected

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*Due to SIP regulations for particulates.

TABLE 2-10

ESTIMATED AIR QUALITY IN AQCR'S WITHOUT MONITORING DATA

AQCR	POTENTIAL QUARTERLY LEAD CONCENTRATION ($\mu g/m^3$)	LEAD CONCENTRATION NEAR MOBILE SOURCES ($\mu g/m^3$)	LEAD CONCENTRATION NEAR INDICATED STATIONARY SOURCES ($\mu g/m^3$) ①								
			FERRO-ALLOY	BATTERY PLANTS	PRIMARY LEAD	SECONDARY LEAD	PRIMARY COPPER	GAS ADDITIVE	CAST IRON	COAL-FIRED POWER PLANTS	OIL-FIRED POWER PLANTS
1	1.23	1.07	<0.01	0.16	--	--	--	--	0.03	0.01	--
6	0.83	0.83	--	--	--	--	--	--	--	--	--
10	NAV ②	--	--	--	--	--	--	--	--	--	--
11	NAV	--	--	--	--	--	--	--	--	--	--
19	1.17	1.09	--	--	--	--	--	--	<0.01	--	0.08
20	2.32	1.26	--	--	--	--	--	--	<0.01	--	1.05
23	0.56	0.56	--	--	--	--	--	--	--	--	--
34	0.85	0.85	--	--	--	--	--	--	--	--	--
35	0.54	0.53	--	--	--	--	--	--	<0.01	<0.01	--
37	1.25	1.25	--	--	--	--	--	--	--	--	--
38	1.10	1.03	--	--	--	--	--	--	<0.01	0.07	--
39	0.61	0.61	--	--	--	--	--	--	--	--	--
40	0.36	0.32	--	--	--	--	--		--	0.03	--
41	3.65	2.32	--	0.16	--	--	--	--	<0.01	--	1.33
44	0.61	0.61	--	--	--	--	--	--	<0.01	--	--
48	4.99	3.09	--	0.16	--	--	--	--	<0.01	--	1.90
51	2.56	1.26	--	--	--	--	--	--	--	--	1.30
63	0.35	0.35	--	--	--	--	--	--	--	--	--
66	1.13	1.10	--	--	--	--	--	--	0.03	0.03	--
71	0.94	0.88	--	--	--	--	--	--	--	0.06	--
72	1.00	0.67	0.06	--	--	--	--	--	<0.01	0.32	--
74	2.42	0.81	--	--	--	--	--	--	0.03	0.03	1.61
86	1.93	1.22	--	--	--	--	--	--	<0.01	0.72	--
89	1.49	1.46	--	0.03	--	--	--	--	0.03	--	--
90	1.09	1.09	--	--	--	--	--	--	--	--	--
91	2.10	2.10	--	--	--	--	--	--	<0.01	--	--
93	0.88	0.88	--	--	--	--	--	--	--	--	--
96	0.72	0.56	--	0.16	--	--	--	--	<0.01	--	--
97	0.25	0.25	--	--	--	--	--	--	<0.01	--	--
98	0.60	0.44	--	0.05	--	--	--	--	<0.01	0.16	0.08

TABLE 2-10 (continued)

ESTIMATED AIR QUALITY IN AQCR'S WITHOUT MONITORING DATA

AQCR	POTENTIAL QUARTERLY LEAD CONCENTRATION ($\mu g/m^3$)	LEAD CONCENTRATION NEAR MOBILE SOURCES ($\mu g/m^3$)	LEAD CONCENTRATION NEAR INDICATED STATIONARY SOURCES ($\mu g/m^3$) ①								
			FERRO-ALLOY	BATTERY PLANTS	PRIMARY LEAD	SECONDARY LEAD	PRIMARY COPPER	GAS ADDITIVE	CAST IRON	COAL-FIRED POWER PLANTS	OIL-FIRED POWER PLANTS
100	0.39	0.32	--	--	--	--	--	--	<0.01	--	0.68
108	1.08	1.08	--	--	--	--	--	--	--	--	--
111	0.36	0.36	--	--	--	--	--	--	--	--	--
117	0.66	0.66	--	--	--	--	--	--	--	--	--
134	3.32	1.51	--	--	--	--	--	--	--	--	1.82
135	1.48	1.44	--	0.05	--	--	--	--	<0.01	--	--
137	1.32	1.24	--	--	--	--	--	--	<0.01	0.08	--
138	12.04	1.08	--	--	11.0 ③	--	--	--	<0.01	0.12	--
144	1.60	1.60	--	--	--	--	--	--	--	--	--
149	0.87	0.47	--	--	--	--	--	--	--	--	--
150	2.06	1.89	--	--	--	--	--	<0.01	<0.07	0.17	--
154	0.86	0.96	--	--	--	--	--	--	--	--	--
155	0.54	0.54	--	--	--	--	--	--	--	--	--
156	1.17	1.17	--	--	--	--	--	--	--	--	--
157	0.59	0.59	--	--	--	--	--	--	--	--	--
165	1.55	1.19	--	--	--	--	--	--	<0.01	0.37	--
168	1.26	1.26	--	--	--	--	--	--	<0.01	--	--
169	1.51	1.47	--	--	--	--	--	--	<0.01	0.03	--
171	3.13	3.00	--	--	--	0.13	--	--	--	0.07	--
175	1.18	1.16	--	--	--	--	--	--	<0.01	0.02	--
177	0.82	0.79	--	0.05	--	--	--	--	0.03	<0.01	--
179	1.63	1.35	0.07	--	--	--	--	--	<0.01	0.28	--
180	0.60	0.53	--	0.05	--	--	--	--	0.03	<0.01	--
182	1.15	1.15	--	--	--	--	--	--	<0.01	--	--
183	1.75	1.59	0.06	0.16	--	--	--	--	0.03	0.15	--
187	0.66	0.66	--	--	--	--	--	--	--	--	--
190	0.98	0.96	0.02	--	--	--	--	--	<0.01	--	--
191	0.34	0.34	--	--	--	--	--	--	--	--	--
192	0.38	0.38	--	--	--	--	--	--	--	--	--
194	1.09	1.09	<0.01	--	--	--	--	--	--	--	--

TABLE 2-10 (concluded)

ESTIMATED AIR QUALITY IN AQCR'S WITHOUT MONITORING DATA

AQCR	POTENTIAL QUARTERLY LEAD CONCENTRATION ($\mu g/m^3$)	LEAD CONCENTRATION NEAR MOBILE SOURCES ($\mu g/m^3$)	LEAD CONCENTRATION NEAR INDICATED STATIONARY SOURCES ($\mu g/m^3$) ①								
			FERRO-ALLOY	BATTERY PLANTS	PRIMARY LEAD	SECONDARY LEAD	PRIMARY COPPER	GAS ADDITIVE	CAST IRON	COAL-FIRED POWER PLANTS	OIL-FIRED POWER PLANTS
198	1.09	0.83	--	--	--	--	--	--	<0.01	--	--
199	3.66	2.19	0.02	--	--	--	--	--	<0.01	0.07	1.47
201	0.80	0.76	--	--	--	--	--	--	--	0.03	--
203	0.58	0.58	--	--	--	--	--	--	<0.01	--	--
204	2.03	1.99	--	--	--	--	--	--	--	0.03	--
206	0.39	0.39	--	--	--	--	--	--	<0.01	--	--
219	0.97	0.93	--	0.05	--	--	--	--	--	0.02	--
224	2.07	2.03	--	--	--	--	--	--	<0.01	0.05	--
227	0.68	0.65	0.03	--	--	--	--	--	<0.01	--	--
228	0.86	0.86	--	--	--	--	--	--	<0.01	--	--
230	1.41	1.41	--	--	--	--	--	--	<0.01	--	--
231	0.45	0.45	--	--	--	--	--	--	<0.01	--	--
232	0.85	0.85	--	--	--	--	--	--	--	--	--
233	0.91	0.91	--	--	--	--	--	--	--	--	--
235	0.89	0.64	<0.01	--	--	--	--	--	<0.01	0.25	--
236	0.95	0.95	--	--	--	--	--	--	--	--	--
245	NAV ②	--	--	--	--	--	--	--	--	--	--
246	NAV	--	--	--	--	--	--	--	--	--	--

1. Data were not available for determining ambient lead concentrations from iron and steel plants and municipal incinerators (Scruggs, 1977).

2. NAV = not available; AQCR outside continental United States.

3. Stack emissions are assumed to be negligible. Fugitive emissions only are modeled.
   126,200 tons/year production 8.69×10^{-5} $\mu g/m^3$/ton product (Scruggs, 1977) = 11.0 $\mu g/m^3$.

ambient lead level in an AQCR, as given in Table 2-10. While it is not expected that the location of the two maximum concentrations would necessarily coincide, the analysis was designed to reduce greatly the probability of underestimating ambient lead concentrations in an AQCR.

Figure 2-7 shows the number of AQCR's which would have been out of compliance relative to different proposed standards based on estimated ambient air concentrations for 1975. Out of the 74 AQCR's with estimated data, almost 49 percent had estimated ambient concentrations greater than 1.0 $\mu g/m^3$ while only 18 percent would have been out of compliance for a standard of 2.0 $\mu g/m^3$.

The estimated maximum lead concentrations from 74 AQCR's without monitoring data are to be combined with the maximum observed concentrations from the 162 AQCR's with 1975 data (see Section 2.2.1) and 7 AQCR's with only 1974 or earlier data. These data are to be used in determining required emissions rollbacks in order to meet possible ambient lead standards. The four AQCR's not included in the analysis (located in Guam, American Samoa and two in Alaska) were not considered to have major sources of lead emissions.

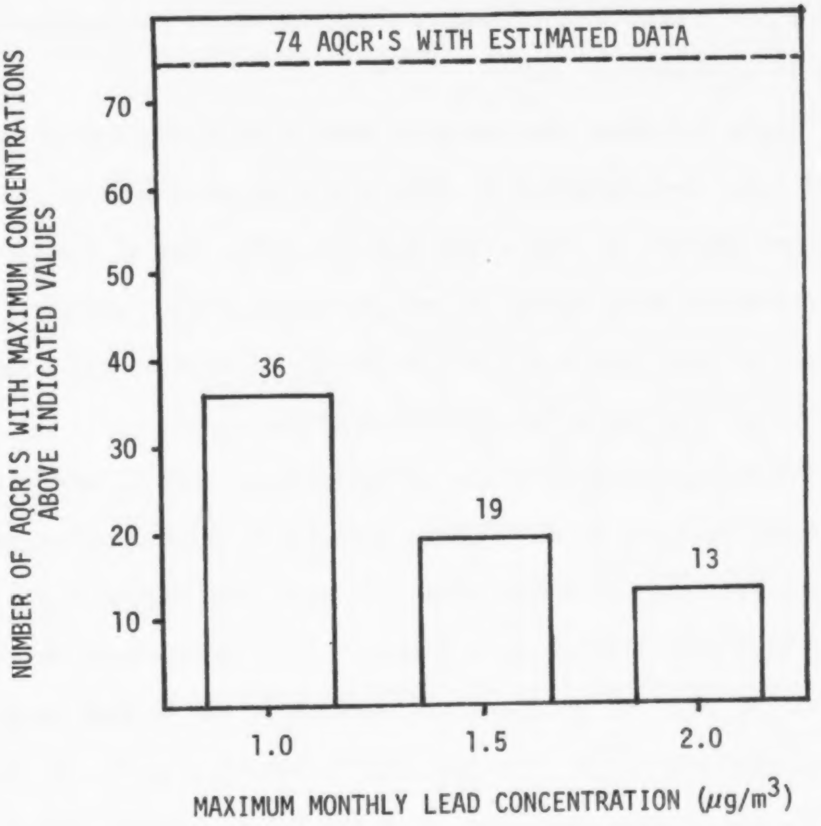

FIGURE 2-7
NUMBER OF AQCR'S WITH MAXIMUM ESTIMATED
LEAD CONCENTRATIONS ABOVE INDICATED VALUES

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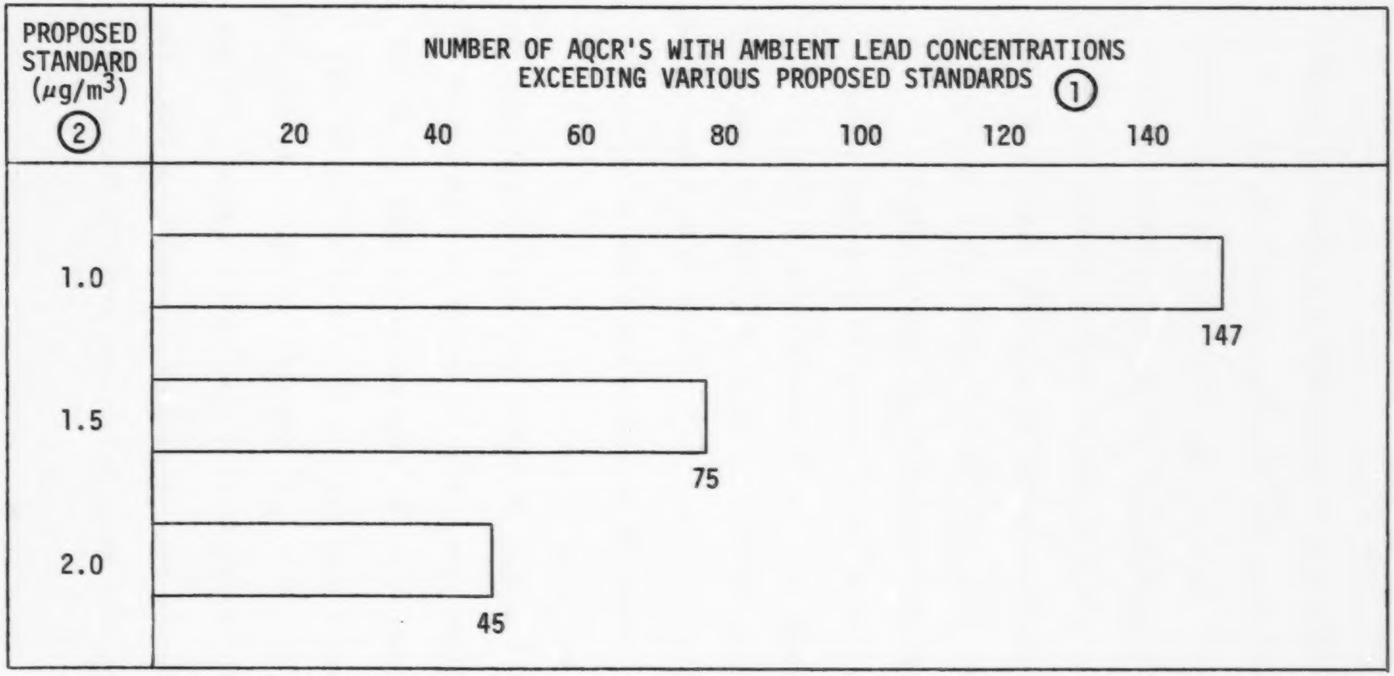
3. ENVIRONMENTAL IMPACTS OF THE PROPOSED STANDARDS

3.1 DEVELOPMENT OF CONTROL STRATEGIES

The environmental impacts of a lead NAAQS are contingent upon the emission control philosophy and specific control strategies adopted by the states with the ultimate authority over those AQCR's whose ambient quality is projected to exceed the standard by the attainment date. In this section, sample control strategies are developed for the purpose of assessing the national impacts of the three possible standards (1.0, 1.5 and 2.0 $\mu g/m^3$, with attainment required by 1982. The probability of these sample control strategies being sufficient to bring the nation into compliance with the proposed standards is closely correlated with the accuracy of the ambient concentrations (both measured and predicted) on which the impact analysis is based. It is not to be inferred, however, that the control strategies developed are those which would necessarily be used by any given state.

Figure 3-1 shows the number of AQCR's with ambient air lead concentrations in the baseline year, 1975, in excess of alternative levels of the proposed standard. A large number of AQCR's (147 out of 243) would require additional control of lead emissions to meet an ambient lead standard of 1.0 $\mu g/m^3$ (monthly average). To meet the less stringent candidate standards (1.5 $\mu g/m^3$ and 2.0 $\mu g/m^3$), 75 and 45 AQCR's respectively would require control. However, by 1982, the year in which the AQCR's must be in compliance with the lead NAAQS,



1. Based on 243 AQCR's for which 1975 ambient conditions were estimated or reported (including AQCR's for which 1974, or earlier, ambient data were reported).

2. Monthly averaging time.

FIGURE 3-1
NUMBER OF AIR QUALITY CONTROL REGIONS (AQCR'S) WITH 1975 AMBIENT LEAD CONCENTRATIONS EXCEEDING VARIOUS PROPOSED STANDARDS

the number of AQCR's requiring control should be substantially reduced due to existing EPA regulations which affect lead emissions to the atmosphere (SIP and NSPS control for particulates and no-lead/phase-down of lead in gasoline--see Sections 2.1.1.3 and 2.1.2.3).

To determine the amount of control which would be required in 1982, the rollback technique was used. When the 1975 ambient concentration was greater than the proposed level of the standard, the percentage reduction of lead concentration in ambient air (rollback) required to attain the standard was computed.* The rollback technique is based on the assumption that the percentage reduction in the emissions of a pollutant is equal to the percentage reduction in the ambient concentration of that pollutant. Thus, a 1975 emissions inventory is necessary to determine the initial emissions rollback required and a 1982 emissions inventory is needed for comparison to determine how much additional control may be necessary relative to the 1975 requirements.

Using the latest available data, a 1975 lead emissions inventory was prepared which includes lead emissions from mobile sources and from the 11 types of major point sources identified in Section 2.1,

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*Percentage rollback =

$$\frac{\text{maximum lead concentration} - \text{proposed level of NAAQS}}{\text{maximum lead concentration} - \text{background lead concentration}} \times 100,$$

where natural background lead concentration is estimated at 0.005 $\mu g/m^3$ (National Academy of Sciences, 1972).

namely: ferroalloy production, lead acid battery production, primary lead smelting, secondary lead smelting, primary copper smelting, lead alkyl production, gray iron production, coal-fired power generation, oil-fired power generation, solid waste incineration, and iron and steel production. The resulting 1975 emission inventory and projected mobile and stationary source growth rates (see Sections 2.1.1.3 and 2.1.2.3) were the bases for estimating 1982 and later lead emissions inventories for each AQCR.

The percentage rollback of 1975 ambient lead concentrations required to meet the proposed standard was applied to the estimated tons of lead emitted in 1975. The resulting number of tons was compared to the estimated 1982 lead emissions to determine whether additional control of lead emissions would be required to meet the proposed level of the standard by 1982. The same technique was used to determine whether the standard would be maintained in 1982 and 1995, and was performed for the three different standards and 243 AQCR's involving approximately 2,900 plants in 11 industrial categories as well as mobile emissions for each AQCR (based on gasoline sales and lead content).

3.1.1 Control Philosophy

There are three basic schemes for the control of lead emissions--stationary source control, mobile source control, and combinations of stationary and mobile source control. Several alternatives are available for achieving each control scheme. The way in which these schemes and options are applied depends on the prevailing levels of airborne lead, the control philosophy followed, and the control strategy devised.*

One possible philosophy is to require uniform control, i.e., that all sources of lead emissions in an AQCR apply the same degree of control. By following such a philosophy, all sources would share the burden of meeting the proposed standard. However, if an AQCR had one or two emitters of large quantities of lead to the atmosphere, the reduction in lead emissions which small sources could achieve (even if they ceased operating) would be insignificant in terms of bringing the AQCR into compliance and in relation to the reductions achievable by larger emitters. The lead emissions inventory (presented in Chapter 2) shows that there is, in fact, a wide range in the quantities of lead emitted by various sources. This large variation may, therefore, render such a philosophy impractical.

Another alternative is to apply selective control, i.e., to require only the larger emitters to control their operations, since their emissions are more likely to be the cause of the maximum lead concentrations. Under this philosophy, the source of the largest proportion of the total quantity would be controlled first, followed by the next largest source and so on until the standard is achievable. This latter philosophy has, generally, been followed in the development of the control strategies presented in this section.

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*For purposes of analysis, control options refer to the many individual measures available (e.g., baghouses, scrubbers, and electrostatic precipitators for point sources; car pools, mass transit, bicycles, alternative engine designs, alcohol blends, alternative octane boosters, and particulate traps for mobile sources). Control philosophy implies a broader outlook--whether to apply controls uniformly on all emitters, large and small, or to select certain emitters preferentially. If the latter course is followed, one develops control strategies consisting of selected options.

3.1.2 Overall Control Strategies

A sample control strategy has been developed for each AQCR expected to be out of compliance under each of the three standards under consideration. Each strategy was developed by applying the best available control technology (BACT) to the type of source from which the largest proportion of the total quantity of lead is emitted. If the resulting rollback was not sufficient, then BACT was applied to the next higher class of emitters, with one exception.* In this instance, a smaller source of emissions was selected, as the residual rollback required was relatively small.

As a result of applying the selective control philosophy, two candidates for additional control are primary lead and primary copper smelters and automotive vehicles. The specific control strategies developed are summarized in Table 3-1. It should be noted that stack and fugitive emissions from the smelters were treated as separate items for control strategy development. It should also be noted that, in one instance, pre-1975 automobiles and other automotive vehicles (i.e., medium-size trucks) were treated as separate source types.

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*For one AQCR, the strategy included control of mobile sources rather than the second highest class of emitters as residual reduction in emissions required (after requiring control of the highest class of emitters) was of a small magnitude.

TABLE 3-1

NUMBER OF AQCR'S PROJECTED TO REQUIRE CONTROL OF LEAD EMISSIONS TO COMPLY WITH PROPOSED LEAD NAAQS

SUGGESTED AMBIENT AIR QUALITY STANDARD AND CONTROL STRATEGY	YEAR		
	1982	1985	1995
1.0 $\mu g/m^3$			
Number of AQCR's Requiring Additional Control for			
• Pre-1975 automobiles only	1	-	-
• Primary copper smelters-fugitive emissions only	1	1	1
• Primary lead smelters-fugitive emissions only	-	1	-
• Primary lead and primary copper smelters-fugitive emissions only	-	-	1
• Primary lead smelters-fugitive emissions plus mobile sources	1	-	-
• Primary lead smelters-fugitive and stack emissions plus mobiles sources	2	2	2
Total AQCR's Requiring Control Measures	5	4	4
1.5 $\mu g/m^3$			
Number of AQCR's Requiring Additional Control for			
• Primary copper smelters-fugitive emissions only	1	1	1
• Primary lead smelters-fugitive emissions only	1	2	2
• Primary lead smelters-fugitive emissions only plus mobile sources	1	-	-
• Primary lead smelters-fugitive and stack emissions plus mobile sources	1	1	1
Total AQCR's Requiring Control Measures	4	4	4
2.0 $\mu g/m^3$			
Number of AQCR's Requiring Additional Control for			
• Primary copper smelters-fugitive emissions only	1	1	1
• Primary lead smelters-fugitive emissions only	1	1	3
• Primary lead smelters-fugitive emissions plus mobile sources	1	1	-
Total AQCR's Requiring Control Measures	3	3	4

Control of combinations of sources other than those shown would not, generally, result in the AQCR's achieving compliance. This is not the case in one AQCR; however, the application of the selective control philosophy led to the control strategy developed.

The control strategies indicated in Table 3-1 for 1982 are those which are suggested for attaining the standards. The strategies specified for 1985 and 1995 are those which may serve to maintain the proposed levels of the standard. For each AQCR requiring control of lead emitters in 1982, the control strategy in subsequent years is the same or pertains to a subset of the controlled sources.* This implies that after the standards are attained in these AQCR's, the maintenance of ambient standards would not require control of additional source types or the introduction of new control strategies, although a higher degree of control may be required within particular source categories.

As noted in Table 3-1, five AQCR's would require additional control in 1982 for the most stringent standard proposed, 1.0 $\mu g/m^3$. For a standard of 1.5 $\mu g/m^3$, the number of AQCR's expected to be out of compliance by 1982 would decrease to four and for a 2.0 $\mu g/m^3$ standard only three AQCR's would need further emissions controls. It should also be noted that mobile-only controls would be needed in one AQCR in 1982 only if the 1.0 $\mu g/m^3$ standard were imposed; for any less stringent standard, mobile-only controls would be unnecessary. In subsequent years, for a given standard, there is a shift from more complex strategies to simpler ones (e.g., fugitive-plus stack-plus-mobile to fugitive-plus-stack to fugitive emissions alone).

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*With the exception of a primary copper smelter in one AQCR which may present a small problem in 1995, but not earlier.

3.1.3 Stationary Source Control Strategies

Some AQCR's are expected to require control strategies only for stationary sources. The types of stationary sources requiring control are projected to be primary lead and primary copper smelters. These smelters have already adopted measures or are in the process of adopting measures to control their stack emissions in order to comply with total-particulate regulations. These control measures have resulted in some control of lead. In most cases, further control of lead emissions only from stacks could not provide the additional reduction in lead emissions, according to the rollback technique, necessary to bring the AQCR's into compliance with the proposed NAAQS for lead. It should be noted that the analysis is sensitive to the amount of total-particulate stack control in existence in 1975 (i.e., the compliance control factor). Since this value is not known for many individual smelters, a nationwide average was employed and the amount of further stack control is not precisely tailored to site-specific conditions.

The lead emissions inventory indicates that by 1982 an important source of lead emissions is fugitive emissions from primary lead and primary copper smelters. In at least one case, the reduction of these emissions would be sufficient to bring the AQCR into compliance.

To control fugitive emissions at primary smelters, it is necessary to provide a building evacuation system to a fabric filter (BEFF). Such a system consists of hoods, ducts, fans, and fabric filters and is believed to be capable of achieving up to a 99 percent collection efficiency. It is projected that 10 to 22 such systems, depending on the standard adopted, will be required. For the purpose of making this projection, it was assumed that each building requiring control within the smelter would be provided with a separate control system. However, this assumption does not significantly affect the projected environmental impacts.

For some AQCR's it would also be necessary to apply mobile source controls, which are discussed later, or even stack emissions controls. Typically, fabric filters and scrubbers are applied for control of primary lead smelter stack emissions, while electrostatic precipitators are employed for the control of primary copper smelter stack emissions.

Further stack control implies techniques above and beyond the best available control technology already (by 1982) on the stacks in response to requirements for the total-particulate NAAQS. Such additional control would require the development of new technology (beyond present BACT) and could prove to be highly unattractive economically with the result that the smelter operators so affected may decide to terminate operations. Before such a drastic measure is taken, however, careful monitoring analyses near these smelters should be performed. Although the present study was based on the best available monitoring data, the information was limited in many cases. Furthermore, it is not the intent of this report to present detailed site-specific information, rather a generalized nationwide overview.

Thus, for purposes of developing strategies and their environmental consequences, it is assumed that BEFF control of fugitive emissions from primary lead and/or primary copper smelters would clean up sufficient amounts of the anticipated point source emissions.

3.1.4 Combined Stationary and Mobile Source Control Strategies

In some instances, the rollback analysis showed that control of both stationary and mobile sources may be necessary to meet the proposed levels of the lead NAAQS. Review of the emission inventories for these areas reveals that elimination of lead emissions from either source category would not be sufficient to bring the AQCR into compliance. Primary lead and/or primary copper semlters are operated in all of the AQCR's requiring a combined point and mobile source control strategy. Quantities of lead emitted by other point sources in these regions are estimated to be less than one ton per year or three orders of magnitude less than the quantities of lead emitted by the primary smelters. The control strategy suggested for these cases is to apply the maximum amount of reasonably available control to the fugitive emissions at primary smelters, and to apply mobile source controls (particulate traps) to achieve the remainder of the reduction required. Thus, some AQCR's would require installation of particulate traps as part of their control strategies. The total numbers of vehicles requiring particulate traps in order for alternative levels of the standard to be met are shown in Table 3-2. Traps on medium-size trucks and replacement traps have been accounted for in these totals. It should be noted that the installation of particulate traps in model-year medium-size trucks would be required in years between those shown in the table to maintain compliance with the NAAQS proposed.

3.1.5 Mobile Source Control Strategies

In addition to the control of primary copper and lead smelters alone or in combination with mobile source control, it is expected that one AQCR would require some control of mobile sources in 1982 to achieve compliance with a standard of 1.0 $\mu g/m^3$. It should be noted, though, that these controls would not be needed by 1985 due to the no-lead/phasedown of lead in gasoline already required under current EPA regulations. Nevertheless, the AQCR would be required to undertake some form of action to reduce mobile emissions, and, since the elimination of the small quantities of lead emitted by point sources would not bring the region into compliance with the standard, a strategy of controlling only mobile sources is proposed for this AQCR. Naturally, states may elect to propose a combination point

TABLE 3-2

NUMBER OF VEHICLES WHICH MAY REQUIRE LEAD PARTICULATE TRAPS AS A FUNCTION OF ALTERNATIVE STANDARD AND TIME

PROPOSED STANDARD (30-day average, $\mu g/m^3$)	YEAR		
	1982	1985 ①	1995 ②
1.0	1,265,300	49,100	8,800
1.5	106,500	26,900	4,900
2.0	58,000	26,900	0

1. Pre-1975 autos and medium-size trucks obtaining their second particulate trap plus model-year medium-size trucks.
2. Medium-size trucks of various ages obtaining another particulate trap plus model-year medium-size trucks.

and mobile source strategy as they are in no way bound to apply the mobile-only strategy used here.

Only one option, the use of particulate lead traps on pre-1975 automobiles, appears capable of providing the necessary 25 to 30 percent reduction in emissions. Although these traps are not expected to be generally available until 1982, the inclusion of this option in State Implementation Plans may provide an incentive to hasten the development and marketing of traps, at least on a limited geographical basis. For this reason, the installation of particulate lead traps is considered a feasible control strategy, and is used in the impact analysis for the AQCR discussed here.

3.2 PRIMARY IMPACTS

3.2.1 Air Quality

Primary impacts are those which can be attributed directly to the action being assessed--setting and enforcing the NAAQS for lead. The two primary impacts which are expected to result from this action are: (a) a decrease in the quantity of lead emitted to the atmosphere, and (b) a decrease in ambient air lead concentrations. Of the three levels of the standard considered (1.0, 1.5, and 2.0 $\mu g/m^3$, monthly average), the most stringent level (1.0 $\mu g/m^3$) applied in 1982 would result in these two primary impacts occurring most often--in 5 out of 243* AQCR's. Thus, the primary impacts (i.e., changes in lead emissions and air concentrations) resulting from the setting of the NAAQS for lead are seen to be limited to a few locations and are discussed in the following sections.

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*Four AQCR's (Guam, American Samoa, and two in Alaska) have been excluded from the analysis.

3.2.1.1 Lead Emissions

A direct impact of setting and enforcing the NAAQS for lead is a reduction in the number of tons of lead emitted annually to the atmosphere. Calculation of the reduction was based on the measured and estimated ambient air quality concentrations presented in Section 2.2 and the rollback philosophy used in developing control strategies in Section 3.1. The reductions required in individual AQCR's were summed to determine the total national reduction which would be required to attain and maintain the proposed lead NAAQS in future years.

Table 3-3 summarizes the nationwide reductions of lead emissions which may result from the various proposed levels of the standard. For the most stringent standard analyzed, 1.0 $\mu g/m^3$ monthly average, a 36 percent rollback of nationwide tonnage, relative to 1975 conditions would be implied. As the level of the standard becomes less stringent, the percentage rollback required decreases. For a standard of 1.5 $\mu g/m^3$, a 20 percent reduction would be implied, and for a standard of 2.0 $\mu g/m^3$, a 12 percent reduction is indicated. The reduction required changes from year to year since the total number of tons emitted varies due to (1) industry growth (or decline), (2) elimination of lead in gasoline, and (3) additional compliance with total particulate regulations.

TABLE 3-3

NATIONWIDE ESTIMATE OF REDUCTION IN TONS OF LEAD EMITTED TO THE ATMOSPHERE TO MEET PROPOSED STANDARDS

STANDARD ($\mu g/m^3$)	PERCENTAGE ROLLBACK, 1975	ADDITIONAL REDUCTIONS BY YEAR, STATIONARY AND MOBILE SOURCES (tons of lead)		
		1982	1985	1995
1.0	36%	2,754	2,435	3,069
1.5	20%	1,979	1,903	2,538
2.0	12%	1,469	1,410	2,006

Standards based on monthly averaging time.

The trend in the reduction for any standard between 1982 and 1995 is a function of these factors and is independent of the level of the standard. In 1985, the rollback required is less than in 1982, primarily because the reduction in mobile emissions (due to gasoline additive and fuel economy regulations) is greater than any increases resulting from more vehicle miles traveled and/or growth in the industrial point source category. But by 1995, the diminishing effect of gasoline additive and fuel economy regulations is not great enough to offset the increases in point source emissions. More specifically, anticipated increases in primary lead production would yield increased lead emissions to the atmosphere, thereby resulting in the need for additional reduction in lead emissions in 1995 relative to 1985.

The reductions in Table 3-3 represent nationwide values for both mobile and stationary sources. The control of fugitive lead emissions from primary lead and copper smelters as well as the control of mobile sources is estimated to account for most of the required reductions. For example, for the most stringent standard, 1.0 $\mu g/m^3$ in 1982, the fugitive and mobile control strategies are designed to effect approximately 98 percent of the total emissions reduction required.* The remainder is attributable to the stack emissions from primary lead or primary copper smelters. It should be noted, however, that these stacks already have (by 1982) BACT* systems. Thus, for purposes of a nationwide assessment, it appears that the indicated strategies--fugitive dust and mobile emissions control--represent a reasonable and comprehensive approach. Of course, the states have the option and the responsibility to develop strategies to suit their individual needs.

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*In this case, fugitive control should eliminate 2,349 tons of lead emissions while mobile control measures should reduce 387 tons compared to a required reduction of 2,754 tons (see Table 3-3).

3.2.1.2 Ambient Concentrations

As presented earlier, Figure 3-1 shows how many AQCR's had either reported or estimated 1975 ambient air lead concentrations that would exceed the proposed levels of the standard. The cumulative influence of regulations (other than the lead NAAQS) which directly control lead emissions to the atmosphere (SIP and NSPS control of particulates as well as no-lead in gasoline--see Sections 2.1.1.3 and 2.1.2.3) are themselves expected to reduce (1) lead emissions by 1982, (2) ambient air lead concentrations, and (3) the numbers of AQCR's (relative to 1975) expected to exceed the proposed levels of the standards. For a standard of 1.0 $\mu g/m^3$, monthly averrage, 147 AQCR's would have exceeded the standard in 1975, while in 1982 only 5 AQCR's are expected to exceed the same level. It is these five AQCR's whose ambient air lead concentrations would have to be reduced further and thereby be affected by a lead NAAQS of 1.0

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*Best available control technology.

μg/m^3. Other AQCR's may also experience reduced lead concentrations because of other regulatory actions, but not as a direct result of the lead NAAQS. Any new facilities, constructed in areas where the lead NAAQS is not exceeded, would have to be designed so their lead emissions during operation would not result in ambient lead levels exceeding the standard.

For a standard of 1.5 μg/m^3, monthly average, ambient lead concentrations would need to be reduced in four AQCR's in 1982, while three AQCR's would require reductions in the same year if the 2.0 μg/m^3 standard were adopted. It should also be noted, though, that four AQCR's would need lead controls in 1995 using the 2.0 μg/m^3 standard, because of growth in the primary lead smelting industry.

3.2.2 Human Health and Welfare

The protection of human health and welfare is the purpose of a national ambient air quality standard for lead. The effects of lead on human health and welfare are addressed in the *Air Quality Criteria for Lead* issued by EPA at proposal. The level of the standard is based solely on health and welfare considerations. The proposed rulemaking preamble contains a statement of basis and purpose which explains the Agency's standard rationale.

3.3 OTHER ENVIRONMENTAL IMPACTS

Using the control strategies specified in the previous section, the cumulative, nationwide secondary impacts likely to result from promulgating a lead NAAQS can be determined. The major secondary impacts which may occur include changes in energy consumption, noise levels, land acreage, other pollutant emissions, ecological implications and costs to industries and state governments.

Assessment of these impacts with respect to stationary sources has been based on the following assumptions:

(a) Control of fugitive emissions from primary lead and primary copper smelters would be achieved through the construction and operation of building evacuation system to fabric filter (BEFF) facilities;*

(b) Such facilities would be located adjacent to the smelting facilities on property already owned and developed by the smelting companies;

(c) Lead emitted from fugitive sources and captured by the BEFF facilities would not be recovered, i.e., the worst case, and therefore landfill operations would be needed to dispose of the material collected; and

(d) Landfills would be located a few miles from the smelters in areas which are presently undeveloped.

When the exact locations of all facilities being constructed as a result of the lead NAAQS can be positively identified, site specific impacts can be evaluated.

The secondary impacts related to the mobile source strategy (the application of lead particulate traps) are based on the assumption that the particulate traps can be manufactured in existing muffler-producing facilities.

It is assumed that the operation of BEFF facilities at stationary sources would be ongoing actions for many years. On the other hand, with regard to the particulate traps, there would be a large initial demand under conditions of the 1.0 $\mu g/m^3$ standard--approximately 1.3 million units, by 1982--with a sharp falloff in production in subsequent years (see Table 3-2). For years later than 1982 and/or for standards greater than 1.0 μg/m^3, the demand for particulate traps would be relatively small.

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*Includes hoods, ducts, fans, and baghouses.

3.3.1 Energy Consumption

Considerations of energy consumption involve the construction and operation of the BEFF's at each of the primary lead and primary copper smelters required to control fugitive emissions as well as the fabrication and operation of particulate traps for reducing automotive emissions. Energy consumption is typically characterized by capital and operating energy demands. Capital energy is defined as the energy required to produce various materials (e.g., structural steel, sheet metal, raw chemicals) and assemble the materials into finished products. Operating energy consists of the energy to run the BEFF fans, to dispose of the collected particulate matter, and to operate automobiles with particulate traps.

3.3.1.1 Capital Energy

Based on (1) the amount of structural steel and other materials used at the ASARCO smelter in El Paso, (2) the ratio of total particulate to lead particulate, (3) the capacity of the BEFF at El Paso, and (4) the tons of lead to be collected at the affected primary copper and lead smelters, the nationwide capital energy costs in 1982 for a standard of 1.5 μg/m^3 are expected to be 3.12×10^{12} and 1.74

x 10^{12} BTU(th)* for primary copper and primary lead smelters, respectively. The capital energy costs in 1982 associated with the alternative standards are shown in Table 3-4. The table also lists equivalent barrels of oil. A comparison with either the nationwide domestic demand of oil at 17.7 x 10^6 barrels per day in 1976 (Federal Energy Administration, 1977) or the 1975 operating energy for the primary lead and copper industries of 30 x 10^6 barrels of oil (based on 1975 production rates and energy factors derived from Bureau of the Census, 1967) indicates that the capital energy costs for retrofitting all the primary copper and lead smelters are relatively small.

The capital energy for the automotive control strategy is considered to be the energy to manufacture the particulate traps. Since the particulate traps would likely be manufactured by muffler manufacturers at existing plants, no new major facilities would have to be constructed and the capital energy is considered to be that which would be expended to provide and fabricate the necessary sheet metal. Under the most widespread application of the most stringent standard, 1.3 million particulate traps** would be required. The capital energy required to produce this number of mufflers is estimated to be the equivalent of 477,000 barrels of oil. The corresponding energy to produce the same number of particulate traps, containing slightly

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*BTU(th) = British thermal unit (thermal)

**Required for the mobile source strategy relating to a standard of 1.0 $\mu g/m^3$ in 1982.

TABLE 3-4

NATIONWIDE ENERGY COSTS ASSOCIATED WITH FUGITIVE LEAD EMISSIONS CONTROL AT PRIMARY COPPER AND LEAD SMELTERS, 1982

LEVEL OF STANDARD ($\mu g/m^3$)	CAPITAL ENERGY		OPERATING ENERGY	
	10^{12} BTU	EQUIVALENT BARRELS OF OIL ($\times 10^6$)	10^{12} BTU/yr	EQUIVALENT BARRELS OF OIL PER YEAR ($\times 10^6$)
1.0	6.7	1.15	1.44	0.25
1.5	4.9	0.84	1.06	0.18
2.0	3.0	0.51	0.67	0.12

more steel and/or aluminum, would be 542,000 barrels of oil. In some cases the particulate traps would be installed on vehicles requiring new mufflers, so the capital energy would be expected to lie somewhere between the two energy values mentioned above. It is important to note that these capital energy requirements for the two devices, mufflers and particulate traps, are fairly similar with the exception of possible retooling, required for particulate trap production, which is unknown but considered to be of a low order of magnitude.

The need for particulate traps for less stringent alternative standards or for later years is generally two orders of magnitude less than for the 1982 case involving the 1.0 $\mu g/m^3$ standard presented above.

3.3.1.2 Operating Energy

The operating energy for point source control is associated with the power to drive the fans in the BEFF and with the fuel to transport and bury the collected particulate matter. Based on a study of the BEFF facility for the ASARCO smelter at El Paso, Texas (Nelson, 1977), it is estimated that the nationwide energy consumption rates for 1982 at a standard of 1.5 $\mu g/m^3$ are 0.63×10^{12} and 0.43×10^{12} BTU(th) for the primary copper and lead smelter BEFF's, respectively.

If it is assumed that the collected material is transported to landfills several miles away, the fuel energy requirements for 1982 at a standard of 1.5 $\mu g/m^3$ are computed to be less than 1×10^9

BTU(th). Even if the energy to operate the bulldozers at the landfill sites were of the same magnitude, the energy for hauling and burial is negligible compared to that for the BEFF fans and is not considered further in the analysis. Thus, the operating energies reported in Table 3-4 represent, for the different standards, the energy to power the BEFF fans. The energy values (for fans at the required BEFF's) are small (less than one percent) in comparison to the annual energy input to the primary copper and primary lead smelting industries. Based on 1975 production values (see Appendices C and E) and energy-per-ton factors for both industries (Bureau of the Census, 1967), the total energy input to both industries is estimated to be 172 x 10^{12} BTU(th) for 1975.

The operating energy associated with the use of particulate traps refers to the power which is needed to force the spent gases through the exhaust system. With the present design of particulate traps there is no appreciable difference in the pressure drop across a standard acoustical muffler and a particulate trap and, therefore, in operating energy required.

3.3.2 Noise Levels

Most of the noise generated by the operation of BEFF's occurs within the structure housing the system where Occupational Safety and Health Administration (OSHA) standards specify that noise exposure levels are not to exceed 90 dBA for an eight-hour workday. Individual pieces of equipment, such as fans which typically generate noise levels ranging from 76 to 102 dBA at five feet (Goodfriend and Kessler, 1973), may not meet these specifications. Therefore, the entire control system including fans, ductwork, and piping should be designed using those acoustical measures necessary to insure that the OSHA noise standards are met. It should be noted that the exposure levels can be increased by 5 dBA for each halving of the exposure time. The U.S. Environmental Protection Agency (EPA) has proposed to OSHA that a maximum eight-hour occupational exposure level of 85 dBA be established within three years of the OSHA regulation and ultimately an eight-hour exposure level of 80 dBA (U.S. Environmental Protection Agency, 1974). Furthermore, EPA proposed that the exposure level can be increased by only 3 dBA for each halving of the exposure time.

Assuming that the OSHA permissible noise exposure levels are met, the exterior sound pressure levels would be less than 90 dBA due to noise attenuation caused by the building walls, ambient air, and nearby structures. Maximum noise levels computed based only on attenuation related to distance, are 70 dBA at 50 feet and 58 dBA at 200 feet. Assuming that the BEFF's are to be at least 200 feet from the property line, noise levels are not expected to exceed typical local noise ordinances (e.g., New Jersey, 1974).

The particulate traps are expected to have acoustical properties similar to those of a standard muffler and any changes in noise levels in the vicinity of roads and highways are not anticipated to be perceivable.

3.3.3 Land Use Parameters

The use of a BEFF system to control fugitive emissions requires space not only to house the system but for the disposal of the particulate matter collected in a landfill area. It should be noted that the space requirements for the BEFF housing represent a one-time allocation, while the requirements for landfill are on an annual basis. The manufacture of particulate traps is expected to occur at existing facilities.

3.3.3.1 Space Requirements for BEFF Facilities

The area* occupied by the baghouse facility consists of the baghouse proper, a transformer substation, ducting, a loading area, and an approach road. The baghouse itself is assumed to vary in size according to the amount of lead particulate to be collected, but the area for the other items is assumed to remain constant regardless of output. Based on the BEFF at the ASARCO smelter in El Paso, Texas (Nelson, 1977), the BEFF area (for additional structures) for the affected smelters (primary copper and primary lead) is estimated to be 4.2 acres for a standard of 1.5 $\mu g/m^3$. This acreage and the acreages according to the other levels of a lead standard are presented in Table 3-5. Relative to the area occupied by a single smelter (e.g., the ASARCO smelter at El Paso itself occupies over 700 acres of land), the space requirements for BEFF's are quite small.

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*External to the existing smelter.

TABLE 3-5

NATIONWIDE LAND USE PARAMETERS ASSOCIATED WITH FUGITIVE LEAD EMISSIONS CONTROL AT PRIMARY COPPER AND LEAD SMELTERS, 1982

LEVEL OF STANDARD ($\mu g/m^3$)	AREA FOR ADDITIONAL STRUCTURES (acres)	VOLUME FOR DISPOSAL (acre-feet)
1.0	6.7	21.6
1.5	4.2	16.0
2.0	3.3	10.1

3.3.3.2 Landfill Considerations

For a standard of 1.5 $\mu g/m^3$, the nationwide amounts of total particulate fugitive dust to be disposed of would be 9.5 acre-feet and 6.5 acre-feet for primary copper and primary lead smelters, respectively in 1982. Landfill factors resulting from the promulgating of the alternative standards are presented in Table 3-5. Volumes (in acre-feet) are listed instead of acreages since the number of acres would vary from site to site according to the thickness of the landfilling operations. Even with a conservative estimate of two feet for the proposed thickness of the landfill layer of disposed dust, the nationwide annual acreage requirements under the most stringent of the standards proposed (1.0 $\mu g/m^3$) would be very small--on the order of ten acres.

3.3.3.3 Mobile Strategy Considerations

Not all of the 1.3 million particulate traps which would have to be installed by 1982 represent new production capacity. In 1972 the annual muffler production in the United States was over 54 million units of which 32.5 million units were replacement mufflers, up from 26.5 million units in 1967 (Bureau of the Census, 1977). Thus, the annual production rate by 1982 may be extrapolated to at least 40 million units. Since approximately one-third of the 1.3 million pre-1975 cars would need a replacement muffler in the 1981 to 1982 time period, by virtue of normal wear, the production of 0.4 million particulate traps would merely take the place of a similar number of mufflers. Production of the other 0.9 million traps would be for cars not needing replacement mufflers at the time and thus represents an additional production capacity of one to two percent if all the traps were produced in one year. The percentage increase would be even smaller if the particulate traps were also manufactured in years prior to 1982 in an effort to build up a stockpile. Any plant expansion of this magnitude could occur on property already owned by muffler manufacturers.

3.3.4 Other Air Pollutants

Control devices installed to reduce fugitive lead emissions from primary lead and copper smelters are also expected to control emissions of other trace contaminants. In order to estimate the magnitude of this impact, the uncontrolled emissions were computed for several pollutants. Fugitive emission factors for trace metals from primary lead and primary copper smelters have not yet been developed. Estimates for the magnitude of trace element emissions were derived from concentrations of the elements found in stack particulates from one smelter (Statnick, 1974) and from particulate fugitive emission factors (U.S. Environmental Protection Agency, 1974a). The remaining estimates (except mercury) were derived from typical concentrations of trace elements in the ores (U.S. Environmental Protection Agency, 1974f), particulate fugitive emission factors, and the assumption that 50 percent of the concentration of the elements in the ores is found in the fugitive particulates. Mercury emissions were computed from a materials balance (Van Horn, 1975).

Table 3-6 represents the estimated fugitive emissions for seven pollutants from both primary lead and primary copper smelters. While the estimates for some pollutants in the table may appear small when considered on a nationwide basis, it must be remembered that there were only a few primary copper and primary lead smelters operating in the United States in 1975. If, on the other hand, for a given AQCR, the primary smelters constitute the major source of the trace elements in question, particulate control at the smelters (fugitive emissions control to provide compliance with the lead NAAQS) would reduce the emissions of the trace elements as much as 99 percent in the vicinity of the smelters. The predicted reduction in arsenic would be significant when compared to the estimated nationwide arsenic emissions of 4,890 tons/year from all types of sources.

The use of lead particulate traps is not expected to alter the exhaust emission characteristics except, of course, for lead (Summers, 1977).

3.3.5 Hydrology

The impact on hydrology likely to result from the lead NAAQS is a change in the lead concentrations of both ground waters and surface waters. The reduction of airborne lead concentrations expected from the enforcement of the lead NAAQS would result in lower lead concentrations for bodies of water by limiting the amount of lead entering

TABLE 3-6

TRACE METALS--ESTIMATED FUGITIVE EMISSIONS AND THEIR REDUCTIONS

TRACE ELEMENT	1975 UNCONTROLLED NATIONWIDE EMISSIONS (TPY)			1982 EMISSIONS REDUCED AT SMELTERS (TPY)		
				STANDARD ($\mu g/m^3$)		
	PRIMARY COPPER SMELTERS	PRIMARY LEAD SMELTERS	TOTAL SMELTERS	1.0	1.5	2.0
Arsenic	2,990	70	3,060	970	590	130
Cadmium	265	520	783	310	280	260
Chromium	6	1	7	2.3	1.6	0.7
Mercury	50	5	55	18	11	4
Zinc	1,900	330	2,230	740	500	220
Beryllium	1	0.2	1.2	0.4	0.3	0.1
Antimony	23	4	27	9	6	3

Source of 1975 Arsenic Data: U.S. Environmental Protection Agency. July 1976. Air Pollutant Assessment Report on Arsenic.

the surface water by direct deposition and/or runoff. Lead concentrations of surface water as well as ground water may increase unless the solid waste collected at the BEFF's is disposed of at carefully sited and well designed landfills. Leachate is a highly mineralized fluid containing such constituents as chloride, iron, lead, copper, sodium, nitrate, and a variety of organic chemicals (U.S. Environmental Protection Agency, 1977c). In confined, slow moving, or relatively low-volume surface waters, leachate has killed vegetation and fish, eliminated spawning areas, and precluded the use of existing and planned recreational areas (U.S. Environmental Protection Agency, 1977c).

Solid waste land disposal sites can be sources of groundwater contamination because of the generation of leachate caused by water percolating through the bodies of refuse and waste materials. Disposal sites located in areas where the water table is close to land surface can produce leachate and subsequent groundwater contamination. In some places, such as low lying coastal areas, the water table is so high that all disposal sites constructed without sufficient natural or artificial barriers would contaminate ground water. Leachate contamination of supply wells can result in adverse health effects as a result of chronic exposure, and can cause severe economic hardships, distresses, inconveniences, and inequities to owners of damaged lands.

Because primary lead and primary copper smelters are located in western states, their disposal sites would probably not be located in areas highly susceptible to groundwater contamination (e.g., low lying coastal areas, wetlands). Under Section 1424(e) of the Safe Drinking Water Act of 1974, only one aquifer, the Edwards Underground Reservoir, San Antonio, Texas has been designated for special protection and there are no smelters in that area whose solid waste disposal would have an impact on that aquifer.

Although small quantities of water would be required for the construction (e.g., in concrete) of the new control facilities, no increase in water consumption is anticipated during the operation of the BEFF's. Moreover, there are no liquid effluents directly associated with the operation of BEFF's.

The use of particulate traps is not expected to have any adverse impact on water use or water quality. Fewer lead emissions onto and near roads imply less lead in any runoff to streams. The disposal of the traps would be either as units removed from the auto or as part of the auto when junked. Some of this metal would be recycled while the rest would be disposed of at landfill sites and junk yards. It is not possible to quantify the impacts due to potential leaching at these unspecified sites.

3.3.6 Topographic, Geologic, and Soil Characteristics

Decreased quantities of lead in the air would cause less lead to settle out onto all types of surfaces including soils. Thus, the lead NAAQS would result in lead accumulation in the soil at a slower rate than if the standard were not established.

Slight changes in topographic, geologic, and soil characteristics of the immediate construction areas may result from grading, trenching, filling, and compacting operations occurring while building the BEFF's. A nationwide total of less than seven acres was estimated for construction of the BEFF's needed to meet the most stringent of the proposed standards (see Section 3.3.3). Because the BEFF's would probably be located adjacent to the smelting facilities on property already developed and owned by the smelting companies and the construction would not involve major excavation for these essentially above-ground facilities, occupying relatively small acreages, no significant impacts on topographic, geologic, and soil characteristics are anticipated.

Even though the landfill operations would result in alterations of topographic and soil characteristics during the excavation and backfilling stages--some topsoil would be lost and/or replaced by subsoil and the local topography would be slightly changed--the extent is anticipated to be small. On the basis of approximately 20 acre-feet of material to be buried (see Table 3-5), and assuming a conservative layer thickness of two feet, the nationwide area involved would be no more than ten acres annually for the affected primary copper and lead smelters. The depth of the landfills is not expected to be great enough to affect geologic considerations.

The manufacture and installation of lead particulate traps should not appreciably affect topographic, geologic, or soil characteristics since existing facilities, with possible minor expansion, would be used.

3.3.7 Historical and Archaeological Sites

Those baghouses which are built as a result of the proposed lead standard will probably be located adjacent to the smelting facilities on property already developed and owned by the companies. Therefore, it is unlikely that any historical or archaeological sites would be affected by the construction of additional baghouses. On the other hand, land used for landfill operations may be located at a distance from the facilities and may be presently undeveloped. When the specific locations of the new landfill sites are identified, it can be determined whether they would involve historical and archaeological sites by contacting local historical societies and references including the National Register of Historic Places and the National Registry of Natural Landmarks.

Any plant expansions to produce lead particulate traps at existing muffler facilities are likely to occur adjacent to the main complex and no historical or archaeological site disturbances are anticipated.

3.3.8 Aesthetics

The addition of a BEFF to an existing smelter would alter the appearance of the complex but the magnitude of this change in an already industrial area is expected to be small since the BEFF would occupy only a small fraction of the area of the complex, would be immediately adjacent to the smelter, and would have a lower profile than the smelter itself. Moreover, the design of a BEFF (general industrial) would be in keeping with the rest of the complex. However, locations designated for new landfills may be located in presently undeveloped areas and the changes in appearance, although temporary and involving only small acreages, may be more obtrusive as vegetation and topsoil are removed.

For the manufacture of lead particulate traps, any plant expansions, if necessary, would likely have the same general appearance as the original building and no adverse impacts regarding aesthetics are anticipated.

3.3.9 Ecological Impacts

Ambient lead concentrations in natural environments should be reduced in the future by the promulgation of the NAAQS for lead. The major overall effect of this action, in conjunction with other lead control programs would be to reverse the present trend of accumulation of lead in natural ecosystems, principally in soils and sediments. Other heavy metals would be controlled to some extent by these programs, particularly at smelters, so that the overall effect of an NAAQS for lead would be a reduction in the environmental burden of several heavy metals.

3.3.9.1 Terrestrial Environments

The establishment of an NAAQS for lead is only one of several factors that would be responsible for reducing the input of lead to terrestrial ecosystems. Roadside areas would be affected primarily by the gradual elimination of lead in gasoline. By 1985 lead emissions from vehicles to roadside environments should be about 11 percent of 1975 levels (see Section 3.1). Because medium-duty trucks may continue to utilize leaded gasoline, lead emissions along highways may never be completely eliminated but would be small in quantity.

Reductions of lead inputs to terrestrial environments due to the control of particulate emissions from stationary sources is expected to be site specific. Under the proposed strategy, fugitive sources within some AQCR's may not be controlled (specifically for lead) if the proposed ambient air standards for lead can be achieved by the phasedown of lead in gasoline and/or ambient and emissions standards for total particulate matter. Since some fugitive emissions may not be controlled, local areas affected primarily by a point source may not experience a reduction in lead input.

Where the lead input to a terrestrial system would be reduced, the presently observed increase in lead concentrations in soils is expected to be retarded. However, the fate of lead already stored in soils is not as straightforward. Because of its relative immobility in soils, existing lead would probably be slowly (over geological time) covered by new soil or carried to streams through normal erosion processes. Lead still would be available to vegetation and the food web as long as the present storage remained in the biologically active surface layers.

Surface deposition of lead on leaves would decline rapidly. This deposition is not believed to be a major source of lead to vegetation itself, rather to those organisms feeding directly on the leaves. Thus, this route would be considerably reduced as a means of transmitting lead to higher species in the food web.

3.3.9.2 Aquatic Environments

Most of the actions that would reduce the input of lead to terrestrial environments would also reduce lead inputs both directly and indirectly to aquatic environments. In addition, effluent limitation guidelines established under the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) would be important in reducing lead in various liquid point source discharges.

As with terrestrial sites, actual reductions in lead in particular aquatic environments are expected to be site specific, depending on the mix of lead sources. For example, coastal ocean water would experience a reduction in lead input from the phasedown of lead in gasoline and the control of point source emissions to the air because these are the dominant lead sources for that environment (see Appendix X). An aquatic environment dominated by the inflow of domestic sewage wastes may experience no change in lead inputs because present legislation sets no lead standards for this type of source.

Despite expected overall decreases in air and waterborne lead concentrations, aquatic ecosystems would continue to receive some lead from terrestrial ecosystems in normal erosion and runoff because of the present large storage of lead that has accumulated in surficial terrestrial soils. Because of this, aquatic environments would not exhibit as rapid a decline in overall lead concentrations as would terrestrial environments. Lead stored in sediments in eroding streams would be transported slowly downstream. High concentrations of lead in sediments in depositional areas such as lakes would be covered by sediments containing less lead as lead control measures become instituted and the storage of lead presently in terrestrial soils slowly depletes by erosion. Lead concentrations throughout the aquatic food web would decline as lead in the water decreases and lead in sediments becomes slowly buried beneath the biologically active surface layers.

3.3.10 Demography

The total labor force required for construction of a BEFF is expected to be met by using local construction workers. The operation of a BEFF would probably require a smelter company to hire two additional people, one for operation and one for maintenance (Nelson, 1977). Even under the most stringent of the standards proposed, only 20 to 22 BEFF's would be required. Consequently no widespread population shifts are anticipated--and none of the related impacts are likely to occur. These would include such community services as housing, medical facilities, educational institutions, public utilities, and public safety organizations (fire and police).

Since the exact nature of the particulate trap production process has not yet been specified, the size and qualifications of the labor force required to operate the facilities cannot be precisely evaluated. If the traps were simply to serve as replacements for the usual attrition of mufflers, it might be possible for those workers presently manufacturing mufflers to be reassigned the tasks necessary for trap production. A majority of the traps, however, would likely be placed on cars not needing new mufflers at the time and an additional work force would have to be hired for a one or two-year period. It does not appear that particularly skilled operators would be needed and most industrial areas have enough unemployment so that unskilled workers could be found locally.

3.4 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The promulgation of an NAAQS for lead involves having to accept some short-term environmental concessions for anticipated long-term benefits. The latter are most importantly reflected in the expected reduction of airborne lead and the subsequent improvement in public health and welfare, while the former involve several short-term commitments of and undesirable effects upon man's environment.

Many of the short-term adverse impacts are expected to occur during the construction stages of such projects as (1) the installation of BEFF systems to control fugitive emissions at smelters, and (2) the creation of landfill areas to accommodate solid wastes. Other short-term adverse impacts would occur if the additive effect of OSHA standards and the lead emission control strategy should dictate the extreme measure of plant closure of all or part of its operations. In this case a notable short-term adverse impact would be the loss of jobs.

The taking of land for construction involves some long-term loss of habitat but in the case of the land used for BEFF operations, this area would be generally adjacent to the smelter within the property lines and relatively uninhabitable. Moreover, the acreage requirments are small (on the order of a few acres total for all smelters). The total acreage needed annually for landfill (to bury dust collected during the BEFF operations) is less than 25 acres and the land is expected to undergo only short-term disruption since the sites can be rehabilitated through revegetation. It should be noted that this short-term disruption will reoccur periodically as new waste is collected for disposal.

A major irony of the mobile portion of the control strategy is that the need for particulate traps is short-lived. Only for the case of the most stringent standard (1.0 $\mu g/m^3$) are these control options needed to any large extent, and even then only for a limited time period. Due to the effectiveness of the Federal phase-down program, the need for this control option is expected to drop dramatically within a few years.

The short-term implications of such a situation could involve the drastic choice of decommissioning these facilities once phase-down becomes effective enough. Alternative actions include a gradual production and stockpiling of traps before 1982 to minimize the size of the additional production facilities needed.

The use of energy represents both a short-term and a long-term commitment of resources. The former relates primarily to the capital energy expended to construct the necessary BEFF systems, while the latter derives from the operational stages, i.e., collecting fugitive dust at smelters. While the manufacturing of traps represents the use of operating energy, whether this use would become long-term depends upon how soon these facilities may be decommissioned. It is not clear how useful the further production of particulate traps would be. Based on the reduction of lead in air, it would appear that the particulate trap program is a temporary option.

While it is difficult to make direct comparisons between the adverse impacts of the proposed action and the benefits which would result, the improvement of human health constitutes the overriding factor behind the promulgation of an NAAQS for lead. The benefit to be achieved is a reduction of adverse health effects which might otherwise occur as a result of prolonged community exposure to lead.

3.5 MITIGATING MEASURES AND UNAVOIDABLE ADVERSE IMPACTS

Among the environmental impacts identified in this analysis are several which can be classified as adverse impacts. These include the consumption of more energy, changes in land use patterns, water pollution, and the production of a large number of particulate traps in a short time. In addition, certain economic impacts discussed in a separate statement can be expected, such as increased costs to car owners, to state and local governments, and to consumers of copper and lead and their products. Measures can be taken to reduce or eliminate some of these impacts. Those impacts which cannot be mitigated are considered to be unavoidable adverse impacts.

3.5.1 Mitigating Measures

Careful siting and design of the landfill sites which would be used for disposal of lead from BEFF's can eliminate or reduce the potential for these sites to pollute surface and/or ground waters. To minimize the aesthetic impact of new landfill sites on surrounding areas, topsoil could be used to cover the disposal site and vegetation reestablished. It may also be possible to dispose of the solid waste from the BEFF's in abandoned mines which may be owned by the primary lead and primary copper smelting companies. To reduce the possibility of lead leaching from the disposal sites, new landfills can be designed such that they would be lined with impermeable membranes. In addition, a monitoring system should be a part of a design to identify failures or accidents at the landfill which result in leaching. Designing the BEFF's such that the lead dust collected could be recycled in the smelting process or buried in the lead mines would minimize the need for additional solid waste disposal sites and their related impacts. Acoustical devices can be incorporated in the design of the BEFF's to minimize their operating noise levels.

With stockpiling, the particulate traps could be manufactured over several years to reduce the impacts of trying to quickly produce large numbers of these essentially one-time-use devices. Particulate trap production facilities are expected to be located at existing muffler plants and, therefore, should blend with the surroundings, having no impact on aesthetics.

3.5.2 Unavoidable Adverse Impacts

Of the impacts identified in Sections 3.2 and 3.3, measures are not available to mitigate some of the adverse impacts. The expense of adding control devices to automobiles and primary lead and primary copper smelters cannot be avoided. The additional energy consumed to manufacture and operate these devices is another unavoidable adverse impact which may be attributed to the setting and enforcing of the NAAQS for lead. Either the state, local, or Federal government would have to pay for the implementation plan development, ambient air monitoring, and standard enforcement, as these are unavoidable costs. Measures to mitigate the increased costs of producing lead and copper and their end products are not available. The magnitude of these impacts varies for alternative levels of the proposed standard, but at none of the levels analyzed are these impacts expected to be of major consequence.

3.6 IRREVERSIBLE IMPACTS

This section identifies the resources which are irreversibly or irretrievably committed as a result of the proposed action, i.e., the establishment of an NAAQS for lead.

Resources are considered irreversibly committed if, as a result of the proposed action, they

(a) Are consumed,

(b) Cannot be recovered and reused, or

(c) Are permanently damaged.

The proposed strategy for the implementation of the lead standard is the control of both stationary and mobile sources of lead emissions. The control strategy (described in Section 3.1) involves

(a) The use of labor and materials in the manufacturing of control systems (BEFF's and lead traps);

(b) The use of labor, materials, and land for plant modification (primary lead and copper smelters);

(c) The use of labor for the installation of control equipment;

(d) The use of labor, equipment, and land for the disposal of dust collected by the BEFF's; and

(e) The use of energy in connection with all the above activities.

From among the above resources, labor and energy should be regarded as irreversibly committed. On the other hand, materials used in the above activities would be largely recoverable for reuse, with the exception of reinforced concrete used in plant construction. Similarly, any equipment would be reusable either as is or through recovery in the form of scrap materials.

It is not anticipated that there would be permanent impacts on the land used; however, depending on use, as a result of the proposed action, land would be temporarily unavailable, e.g., land used for disposal sites. No permanent hydrological or ecological impacts are anticipated nor is there any anticipation of permanent effects on topographical, geological, or soil characteristics.

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